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A DISCUSSION OF AN ARTICLE ON MATHEMATICAL ABILITIES AND PHYSICS.

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The title of Mr. Lohr's article (A Study of Mathematical Abilities, Powers, and Skills as Shown by Certain Classes in Physical Science, SCHOOL SCIENCE and MATHEMATICS, November, 1925, pages 834-844) suggested that another teacher of physics had weighed the teachers of mathematics in the balance and found them wanting, and I was ready to spring to their defense. Hence it was with a great deal of satisfaction that I noticed that in his conclusion Mr. Lohr does not have a single fault to find with the mathematics teacher but contents himself with pointing out that "The duty of the physics teacher is to re-teach" and that "It requires a very special ability to apply science in the problematic situation even after the mathematical process is sure."

Since Mr. Lohr has thus treated the mathematics teacher with unusual kindness, I shall attempt to explain why the pupils did not make better scores. Only a few days ago at a departmental meeting of the Hyde Park teachers ways and means were considered for cooperating with and receiving suggestions from the physics department so that the work in algebra might prepare the pupils better for the mathematical work in the physics classes. More such cooperation is needed.

The ideas that came to my mind as I read the exercises in the test are stated after each exercise:

1. A boy measures the radius of a circle and finds it to be 24.32 in. The exact radius is 24.30 in. (a) How much error did he make in measuring? (b) What is the percent error in his measurement? (c) What would be his percent error in the area of the circle, if he used his measurement instead of the correct radius in calculating the radius?

In 1 (b) I feel sure that many pupils failed because they did not know whether to find the ratio of .02 to 24.32 or to 24.30. The physics teacher assumes that the pupil has learned this somewhere. But in his mathematical work similar problems are usually stated as follows: A man buys a car for $800 and sells it for $900. What is the per cent of profit on the cost? What is the per cent of profit on the selling price? Invariably textbooks are very explicit in their statement of whether the gain or loss shall be compared to the smaller or the larger number. The pupil therefore expects an explicit statement and knows that both ratios have a meaning. Hence the exercise as stated in the test was ambiguous to many pupils.

To answer 1 (c) correctly the pupil must remember the formula for the area of a circle, and he must decide whether to use 3 1-7 or 3.14 or 3.1416 as the value of π. Moreover, the more up-to-date his mathematics teaching has been, the more confused will be the pupil's reaction to this exercise. If his teacher has followed the recommendations of the National Committee on Mathematical Requirements, the pupil has been taught the value of significant figures and the pupil would retain only 4 figures in the area of the circle. His results might then not agree with the expectations of the examiner. Further, this up-to-date teacher has frequently been told that there has been an undue amount of emphasis on the use of many decimal places, and hence the pupil has received very little practice in the use of decimals beyond hundredths.

2. Show by a bar graph, using cross-ruled paper, the relations given in the table below:

Number of Tons of Coal Used in a Factory.

January	1,500	May	1,100	September	1,600
February	1,400	June	1,100	October	1,400
March	1,250	July	1,200	November	1,350
April	1,200	August	1,250	December	1,300

Here the mathematics teacher has doubtless been negligent. Most of them believe that the study of graphs does not belong in an algebra class because it is too *easy* a subject. Thorndike, on the contrary, says "To read a statistical graph is within the power of the high-school student untrained in algebra. . . . But to make them offers such difficulty that only the exceptionally gifted child might be expected to master it without specific instruction." (Psychology of Algebra, pages 73-74). One of the reasons for the difficulty with this topic is that the pupil must exercise considerable good judgment in the selection of a

proper scale for the graph. If the examiner had added to his question the brief remark "Let 100 tons = 1 unit of length on the paper" the per cent of correct results would have been very high, provided that the pupil has ever been taught graphing at all. In the Chicago public schools this topic is taught extensively in the 7th and 8th grades (if the teacher follows the prescribed course of study—I say "if" because I heard one principal estimate that only 50% did follow the course). Hence the high school teachers will have an added excuse for neglecting the topic entirely.

3 (a). Make a line graph to show the relationship expressed in the equation $C=5(F-32)/9$, plotting the corresponding values of 80, 70, 90, 100. Let the values of C be laid off horizontally and the values of F vertically, the distance between two heavy lines being equal to 10 degrees. (b) What is the value of F when C = 95 as shown on your graph?

First I might ask: Do the numbers 80, 70, 90, 100 refer to values of F or of C? The problem is evidently not clear. Next I note that the given equation is $C=5(F-32)/9$ and the instructions are "let the values of C be laid off horizontally and the values of F vertically." This is decidedly contrary to all the previous experience of the pupil. Since the equation expresses C in terms of F the pupil would expect to put the values of F on the horizontal axis and the values of C on the vertical axis. Doubtless the pupil was puzzled. If the pupil is asked to draw the graph of $2x+3y=4$ he first solves the equation for y and then puts the values of x on the horizontal axis. If the pupil is to graph $3u+4v=5$ his first question is "Shall I solve for u or for v." If he solves for v, then he puts the values of u on the horizontal axis. That is the tradition in the mathematics classes.

4. (a) Write the reciprocal of $6/9$; and (b) of 2.

The examiner thinks that the pupil should know the meaning of "reciprocal" because the pupil uses the rule "To divide by a fraction, multiply by its reciprocal." But many pupils have never heard of this rule. Their rule says "To divide by a fraction, invert the fraction and multiply." Further, since psychologists have tabood rules and explained that it is sufficient merely to be able to understand the process, many pupils can perform the necessary operations although the word "reciprocal" is not in their vocabulary. Is the word "reciprocal" such a very important one in physics?

5. 40% of the boys in a class is 4% of the girls in school. There are 400 girls in school. How many boys are there in the class?

On first reading this problem I was reminded of the classic problem about 3 cats catching 3 rats in 3 days, etc. No problem as complicated as this one was mentioned in the article by G. W. Reagan, "The Mathematics Involved in Solving High School Physics Problems," SCHOOL SCIENCE AND MATHETICS, March, 1925, pages 292-299.

6. Multiply .039 by 4.60
7. Divide .0179 by .000475
8. .04 is .4% of what number?
9. If 4/9 of a yard of cloth costs 14/27 dollars, what will 5/8 of a yard cost?

Exercise 6 is a good problem but ex. 7 is not because there should be the same number of decimal places in the dividend as in the divisor. The pupil who has been taught to "round off" his numbers so that they all have the same number of significant figures will have .000 as his divisor in ex. 7. The teacher of physics who wishes to learn what is going on in the arithmetic classes should read the article "The Influence of Standardized Tests on the Curriculum in Arithmetic," by Clifford B. Upton in THE MATHEMATICS TEACHER, April 1925, pages 193-208. Many pupils who could solve a problem like: 24 is 6% of what number? or 1.8 is 3% of what number? would miss ex. 8 because there are *too many* decimals in this problem. The pupil has never had any practice with figures as complicated as the examiner has here used. And, to judge from Mr. Reagan's article, such complicated figures seldom arise.

10. In the equation $S = \frac{1}{2}gt^2$, $g = 32$ and $t = 6$. Find the value of S.
11. In the equation $V = \sqrt{2gs}$, $g = 32$ and $S = 800$. Find the value of V.
12. Express 3/17 as a decimal.
13. If $W = VA$ and $A = V/R$, what is the value of W in terms of V and R?
14. Simplify the following expression:
$a+b-(c-d)+a-(b+d)+b+c-d$
15. What is the value of F in the equation $I/F = I/D + I/D'$?

Exercises 10 and 11 are good exercises. Note, however, that the pupil who works ex. 10 and ex. 11 correctly and finds a numerical value for S and V will think that in ex. 13 he should also find a numerical value for W. In all three of these exercises the same phrase is used "Find the value." The pupil would not be so easily mislead if ex. 13 had stated "Express W in terms of V and R" or, better still, "Write an equation for W in terms of V and R." But even this change will not help the pupil unless he has been taught the meaning of the phrase "in terms

of." The physicist will find that this phrase is not extensively used in the first or second courses in algebra. In my own classes I have seen so many pupils misunderstand this phrase that I always take special pains to explain the phrase at great length when it is first met. The same objection that applies to ex. 13 applies to ex. 15 also. In an algebra text ex. 15 would be stated simply: Solve the equation $I/F=I/D+I/D'$ for F. If the examiner wishes to find out what the pupil knows about algebra or what the pupil may have learned in an algebra class, the terminology of the algebra class must be retained. Even the notation should not be changed too much. The letter I is not much used in algebra texts; too often it is misread as the number 1.

16. The radius of a sphere is 6 in. (a) What is the diameter? (b) What is the area of a section through the center? (c) What is the area of the surface of the sphere? (d) What is the volume of the sphere?

Perhaps in the 8th grade in the study of mensuration the pupil learned the rule for finding the area of the surface of a sphere. The chances of that rule being used in the 9th grade are very slight; in the 10th grade no reference would be made to the rule; in the 11th grade the formula would doubtless be used as an application of numerical computation with logarithms. The same remarks apply to the rule for finding the volume of a sphere. If the examiner wished to find out how many pupils could use a formula, he should have stated the question as:

The volume of a sphere is found by multiplying the cube of the radius by $4\pi/3$. Write this rule as a formula. Find the volume of a sphere whose radius is 6 in.

Or, if the examiner wished to find out how much the pupil remembers about a sphere, the question should be worded simply:

What is the rule for finding the volume of a sphere?

As the problem is stated by the examiner we can not conclude whether the difficulty is due to ignorance of the formula, ignorance of how to use a formula, or is due to the fact that the pupil was never taught anything about a sphere. Moreover, the general attitude of pupils towards formulas is "Do not bother to remember them. In real life if you need one, you can find it in a book." And I agree with this attitude. Let us make the school life as near to real life as possible.

In ex. 16 (b), many pupils doubtless did not know what was

meant by a "section" of a sphere. They have never used the word except when asking for a football ticket in Section G or H. The word is used chiefly in the classes in solid geometry, and how many of the pupils had studied solid geometry? From the statistics on page 842 I infer that 7 of the high school pupils had done so; and, according to page 838, 9 high school pupils solved this problem. One might as well ask the pupils something about the co-factors of the minors of a determinant and then conclude that the pupils knew nothing about sets of equations.

17. What is the capacity of a box 8.03 ft. long, 6.48 ft. wide, and 4.2 ft. high.

Note first that the three dimensions have not all been measured with the same degree of accuracy, unless 4.2 means 4.20 in which case it should be so written. If the examiner wished to test the accuracy of some work in multiplication then he evidently regards 218.54448 as the only correct answer. But the pupil who has been taught the rule "When multiplying two approximate numbers do not keep more significant figures in the product than there are in that factor which has the smaller number of significant figures" might give the answer as 220 or 218.

Also, was there any particular reason why the word "capacity" should be used in the exercise rather than the word "volume"? The pupil is accustomed to the latter word. We talk about the capacity of a motor truck meaning a certain number of tons, and about the capacity of a street car meaning a certain number of passengers, and about the capacity of the gas tank of an automobile meaning a certain number of gallons. The fact that so many pupils solved this exercise correctly merely shows that the pupils were successful in "reading into" the problem what they thought the examiner meant.

18. The distances which two opposing football teams gained by the use of the forward pass were inversely proportional to the score. The game ended 21 to 6 and the winning team made 22 yards on forward passes. How many yards did the losing team make on forward passes?

Some time ago I asked some physics students to write as a proportion the statement "The volume varies inversely as the pressure" and the pupils answered that my question was ridiculous because this was not a question involving similar triangles. To know that four lines can be proportional and to be able to write the proportion in a geometric exercise does not in any way help the pupil to understand that *two variables* can be propor-

tional. The teacher of geometry has very likely emphasized that the word "proportional" cannot be used at all unless we are dealing with *four* quantities so that the quotient of the first two can equal the quotient of the last two. Here the examiner would be justified in finding fault with the mathematics teacher because the latter should take time to discuss how the word proportional is used in stating many of the relations of science. But the exercise involves the use of an *inverse* proportion. I doubt if a problem on *inverse* problems is studied in the 9th grade. (I admit it ought to be.) There are perhaps two exercises in all the 10th grade work in geometry wherein inverse proportions are used. Without stopping to examine the text books I can think of only one: The altitudes of a triangle are inversely proportional to their corresponding sides. And the second course in algebra has always been such a crowded one that few teachers touch on the question of proportions at all, unless it be to mention that in a proportion the product of the means equals the product of the extremes. The second course in algebra could well devote less time to the study of factoring and fractions and more time to translating physical laws into algebraic relations.

Even if the pupil does understand inverse proportions, exercise 18 would confuse the pupil. It contradicts his experiences with the game of football. Just why should the losing team gain three times as many yards as the winning team? The problem does not seem true to life.

19. There are 39.37 in. in one meter. One meter equals 100 cm. How many centimeters are there in 24.35 in?

20. An aeroplane flies 2,000 miles in 16 hours and 23 minutes. What is the average speed per hour?

21. What is the capacity of a cylindrical vessel 50 cm. in diameter and 75 cm. deep?

In ex. 21, I venture the guess that many pupils did not know the formula for finding the volume of a cylinder because they had not used it since they were in the 8th grade.

On page 841 Mr. Lohr admits that the given test may not be a valid test of mathematical abilities; he aims to discover merely what arithmetic processes need to be retaught by the physics teacher. The teacher of mathematics can help the physics teacher by placing more emphasis on those items which are listed on page 841.

In the Algebra of Nicholas Saunderson, published in 1741, appears the following problem:

"Whoever makes a tour around the world the earth must necessarily take a larger compass with his head than with his feet. The question is, how much larger?"—*Selected.*

"NEW WINE IN OLD BOTTLES"[1]

By Prof. George W. Hunter,
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The average home of today is a laboratory—with better equipment and more interested students than most of our high school laboratories which I knew when I was a boy. This age of science in which we live is manifestly practical in every phase of home life, from the kitchen to the living room—from the electric washer to the radio outfit. There is need for the present day teacher of science to be on the alert or his students in class and laboratory will be able from the practical standpoint, at least, to teach him everyday science. New wine, new ideas, and new methods must be poured into the old bottles of classroom and laboratory if we are to serve as leaders of the coming generation of men and women.

Someone has told a good story recently in which the Devil is transported to New York where he is strolling with a friend on Fifth Avenue. His friend points out to him the beautiful churches lining the thoroughfare and asks him if he is not afraid of what these churches might do. And the Devil replies, "No, these churches work only on Sundays, and I work all week." Then his friend points out some of the museums, schools and colleges and asks him if these do not make him fear for his rule, but the Devil retorts by saying that these institutions closed at night and that he works all night. As they strolled up the avenue the friend pointed out libraries, hospitals, organized charitable institutions of various sorts and suggests that these at least have cause to make him fear. The Devil, however, in every case had a comeback and had no fear for his kingdom. But the story goes on to say, as they sauntered on up the avenue, the Devil suddenly grew pale and shivered. His friend turned and looked up the street saw an Idea coming down toward them in conversation with someone. The Devil pulled himself together and finally plucked up courage enough to approach the Idea. He was seen to speak and ask a question or two. Then he turned and came back to his friend, reassured and smiling. On being asked why the change in his appearance the Devil answered, "I am perfectly safe; the Idea is in the process of being organized."

[1]Read before the General Science Section of the Iowa State Teachers Association, Des Moines, Iowa, Nov. 6th, 1925.

This attitude of the Devil toward organization leads me to the first suggestion as to the nature of this new wine, which I suggest we should pour into our old bottles. The teaching world at the present time is overorganized. We are testing our teaching results, we are testing our classes, we are testing our methods, we are testing our textbooks in an attempt to standardize our work and perhaps to standardize the minds and abilities of our students. Never in all the life of our public schools has work been better standardized or more widely supervised. Never have educators been more anxious to measure the results of achievements. Never more exact or more rigid methods of rating achievements in teaching have been in use. Never in educational history have we been able to plan our work as to reach the abilities of the individual students. And never more widely, I would venture to say, has the individual student been lost sight of so completely in the complex world of modern school machinery. The school expert of today inflicts this instrument of the new inquisition, the intelligence test, on his or her classes, with what result? Is science reduced to learning definitions? This is what it has come to in some schools. In more than one school I could name to you, I have found teachers actually drilling students on a list of test words in General Science taken from a well known test promoted by one of our foremost educational institutions. The purpose was obvious.

Here then is some new wine that has become soured and should be refermented with the yeast of common sense. If I understand the value of the test in teaching, it is largely two-fold. First, it enables the teacher to measure the standard of achievement (usually memoriter) of certain laboratory work of textbook study and class discussion. It enables him to measure and drive home principles and gives him a partial basis for the promotion of students. For the student it should (but seldom does) teach him to think straight under stress and to learn his own weak and strong points in the assimilation of and remembrance of subject matter. But no testing should result in the degradation of science on the part of the student to the learning of definitions and set phrases. Our University brethren hardly know what they were starting when they moved the first science test down the mountain side of pedagogical experimentation—an avalanche has been started which, if some of us do not have a care, may dash down some of the science foundations on which

we of the secondary school have built—the foundations of laboratory experiment and home project.

Let us then re-ferment this new idea of the intelligence test by using it in an intelligent way. Let us use the new tests, the completion test, the false-true test, the selection test, the vocabulary test and all the others, but let us use them as adjuncts to our science work and not as the end and aim of our courses. The greatest value of the modern test is that it saves both pupils and teachers the fatigue of the long examination. The old ten-question, two hour type of examination has no place in the modern science curriculum. Its place should be taken in the name of efficiency by the modern test. But let us think of our students as human beings and not as question marks. Let us humanize our science, instead of attempting to spend so much time in measuring the results of achievements, which two weeks after the examination is over, mean little or nothing in the lives of either student or teacher.

A second need for new wine in old bottles comes in the reorganization of our science programs for teachers in our secondary schools. The modern junior and senior school is a complex organization. Even in the small schools there come demands on teachers' time quite unknown to those of us of two or three decades ago. We decry the lockstep and are forced into it by our large classes, our slavish willingness to be forced along the line of least resistance by sometime unsympathetic supervision. How many of us really have time or energy for individual work with individuals? You in the small school are burdened with several different types of work often far remote from the specialty in which you have been trained or from the line of your greatest interest. Statistics gathered by Miss Bishop of the University of California, show that in the smaller high schools of California there are individual teachers who handle from two to ten subjects with the greatest number of teachers taking care of four subjects. From 5 to 50% of the staff in small schools teach science. This indicates a considerable waste and reduplication of effort on the part of these teachers. In all high schools of California 804 teachers taught science subjects in 1923-24; 47% were assigned to combinations of science with other subjects. in small schools with less than 200 pupils all science programs were given to relatively few teachers; in medium sized high schools (200-500) nearly 50% had all science; in large schools of over 500, 83% had all science programs. This is repeated in

other states and statistics, I am sure, would show a similar state of things in Iowa. General Science as a sole assignment is a rare occurrence and yet, I venture to say, that if taught properly General Science should take more time in preparation than almost any other subject. How much time under present conditions can an earnest teacher use in interesting individual pupils, in aiding in the solution of their problems and in giving time to the project needs of individual pupils? How much time can a teacher, under such conditions, give to the pupils of more than average ability, those who are to be the leaders in the coming generation?

What are we to do about this situation? It is time to inaugurate a country-wide drive on the part of teachers of science toward making school supervisors, superintendents, and principals see that science values cannot have their realization unless more time is allotted to science teachers for intelligent preparation of work. Science has now become an integral part of the school curriculum. Its values have been shown by experiment to be greater than almost any other school subject. Supervising officials should know this and yet too often we see General Science turned over to the football or basketball coach as part of his program. Not that coaches do not make excellent teachers, I sometimes think that they are the best because of their slant on out-of-door life, but they have football team or teams to look out for and that is their job in the fall of the year when the lure of the out-of-doors should appeal most to the teacher of science. We have reached the stage when we do not have to fight for the life of our subject. Science in the high school is finding itself, has found itself, if statistics mean anything. Those of you who are familiar with the recent reports on the statistical study of science relations, know that general science and the biological sciences have made wonderful rapid strides in the last decade. If the junior high school grows, elementary science in some form or other will have an important part to play in the make-up of the curriculum. Teachers of science must now take the aggressive and show the supervisors how much more could be done with the time now devoted to subjects they are less prepared to teach. They must be prepared to show the values of science in the high school curriculum.

There is need today for a real evaluation of the aims of science in the secondary schools. What use is there in testing the results if the aims are undefined? Changing conditions of home, com-

munity and social life have made new demands and brought about new aims in education. The Junior High School is one result of these changes. This has been brought into existence through the physical necessity of taking care of the immense numbers of pupils coming to our high school doors. The social needs of our pupils in this age demand adjustments in science work. The complex physical environment is another factor we cannot lose sight of in evaluating our science courses. And most of all the age of our boys and girls is a challenge—a challenge to develop new methods and new subject matter. Methods and subject matter that will first of all allow them to develop along the lines of their own interests, which will make them better able to intelligently interpret their own particular environments, which will make them better able to adjust themselves to these environments, which will lead them to more intelligent interests in science so that they may follow up these interests in their later life. So many writers have suggested that it is the preview of science given in the Junior High School or in the first year of the four year high school, that enables students oftimes to find interests and make contacts that will enrich their high school experience and may lead them into their life work. Every old teacher has had this experience, that of the successful student coming back to his old teacher and saying, "It was in this room and under your guidance that I saw my pathway to the future illumined." You have had this blessed experience and I have had it. How much richer experience would be that of the elementary science teacher who holds the torch to many instead of a few. This thought gives promise for much new wine to be bottled.

Another thought is that if our elementary science should both interpret the environment of the child and yet give him a preview of science, it should be given to him in a way that will be both natural and interesting. How do youngsters like to do things? They have a problematic outlook on life—witness a child at play. His very instincts demand both knowledge of facts and a method of using these facts. I have often repeated the phrase, "children are pragmatists." I still think so after over twenty odd years of teaching experience. The method of the problem and the project applied in a hundred and one practical ways that modern science has shown to us, offer to the wideawake teacher and the active pupil plenty of new kinds of wine to be bottled as worthwhile experiences. There are so many ways in

which science affects boys and girls in home or school or community relations. And there are almost as many individual interests as there are children in your classrooms. Tie up your individual problem with the individual interest of your child and there you are. You may, praise be, have at that moment helped that youngster hitch his wagon to a star. You may have helped him to see for himself the way to his future salvation.

But, you say, this is too vague—be specific—what are some of the leads for the laboratory and classroom? These problems are as many and as specific as the various school positions you hold but there are some ways of approach that might be new enough to be bottled as new wine. One, is the method of the survey. Field work is always fascinating, be it an ecological field trip or a visit to a manufacturing plant. But when this field work becomes practical and applicable in the lives of the boys and girls who are at work, then science really arrives.

Let your class start on a practical survey of their own homes with reference to scientific efficiency equipment. Let them make a survey of the family medicine chest to see how many patent medicines are held therein and then let them look up the alcohol content of the said medicines. Let them make a good road survey of their community, a sanitary survey of their neighborhood, a factory survey to discover practical methods of life protection and efficiency in production. You can add plenty more suggestions as good as these. Use some scoring device which can be discussed as classroom exercises and used to summarize the field work and you have a new wine that is sure to be a popular brand.

Another fascinating field of applied science is found in a statistical study of health conditions in your own town as compared with other parts of the county, state or country. Graph making becomes a pleasure when comparisons can be made which touch local conditions. In some parts of the world vaccination is compulsory while in other parts of the world it is not. Take for example a comparison of smallpox in different parts of the United States. In the five year period in the United States from 1908 to 1924 there were 300,000 cases of smallpox. During this period there were over 25,000 cases reported in the State of Illinois alone, and during that same period there were 114 cases reported from Massachusetts, this gives a good comparison of incomplete as against complete law enforcement. In the year 1923, Massachusetts reported 6 cases, California with a 500,000 less population reported 2,029 cases; North Carolina

with about 1,000,000 less, 3,352 cases; another comparison of of law enforcement as against partial law enforcement. In 1923, 30,000 cases of smallpox were reported in the United States; 31,000 in Russia, 195 cases in France, and only 17 in Germany. Another case of inefficiency vs. efficiency in law enforcement. Examples of this sort might be multiplied. The weekly bulletins of the Public Health Science, State Boards of Health bulletins and the vital statistics of your own community will afford data from which comparisons may be drawn. Socialized science of this type is good wine and new wine.

Which brings me to a new bottle, a new idea, which may be strong wine to some and very sour wine to others of this audience. I refer to the association of social science with general science. For sometime now we have seen repeated attempts to substitute in the secondary school curriculum a social science such as community civics for elementary science. Usually this attempt has been unsuccessful. If you will analyze the subject matter you will see why. We cannot teach patriotism through platitudes any more than we can teach community civics through the medium of a textbook. Social science, like any other science, is best taught by the laboratory method. Civics, applied through the medium of a scientific study of the community through the laboratory approach, will then find its true place in the curriculum of the secondary school. And community science studies will best lend themselves to this approach. Why should not civics teachers and science teachers get together and work out their problems in common? Thus the administrative tangle now caused through the conflict of social science and pure science will be eliminated and the pupil, now lost sight of in the battle, will come into his own. Try a bottle of this wine, you may like it.

Another phase of the science situation that bothers some of us is the existence of laws in many states which make the teaching of physiology mandatory and particularly the teaching of temperance physiology. The W. C. T. U., a powerful body politically in the past, is no less effective an organization today. A recent memorial by the National and State Departments of Scientific Temperance Instruction of the Woman's Christian Temperance Union, sent to educators and authors of textbooks indicates that they still expect to carry on their fight against alcohol. We, of the teaching profession, sympathize in this aim although most of us decry the absolutism of the laws in question.

We are willing to carry on any rational campaign against alcohol that may be effective, but we know that the methods of pre-prohibition are not effective today. Furthermore we know that teaching of this sort is not effective when given as "twenty pages of a textbook, in the school year up to and including the ninth grade," to quote an abstract of one state law. Let us here again use new wine for our old bottles. Effective propaganda must be up to date, it must deal with the moral and civic aspects of law breaking, of the physical dangers of "hooch" and homebrew and of the physiological effect of alcohol with reference to human efficiency. Children are not particularly interested as to the length of life of drinkers for they see plenty of people who drink moderately living to a ripe old age. As a matter of fact the recent statistics of Raymond Pearl indicate in a given experimental group that moderate drinkers were slightly longer lived than the total abstainers, only the heavy drinkers showing a shorter life expectancy. Habit forming comes early and the alcohol habit is no exception. Stress this phase, as in the use of drugs and narcotics. The best way to attack this problem is to incorporate scientific temperance physiology as part of our elementary science work, emphasizing habit side and making it a part of the treatment of a later fight against patent medicines. Laboratory and field work along this line is easy. Surveys of town drug stores will stir up further opinion against the use of certain patent medicines of high alcohol content and another series of observations directed against the testimonial evil and worked out through the current newspapers will make vital projects for several boys and girls. Public opinion can be molded by such means. And the illegal liquor traffic, now firmly established in most communities, can only be forced out by concerted action by means of molded public opinion. This, in turn, will only come through education. For the school child of today is the voter of tomorrow. Try then the new wine of laboratory work in temperance physiology, carried out as part of your Junior and Senior High School general science program and see if it is not worth the bottling.

There are many other new brands of wine that I could offer for your sampling were there time at my disposal. Specific questions of methodology, the substitution of the demonstration experiment for the individual work in the laboratory with beginning, (not advanced), students in science is one question worth your consideration, another is what types of units of work will

satisfy certain local needs in a community; another is the value of elementary science in vocational guidance work. There are literally scores of new ideas waiting to be tried out and used in our laboratories. But I will take time only to present one final thought for you to pour, if you will, into the channels of your school winepress. As someone has well said we must start in general science, continue in general science and end in general science. More and more, elementary science needs to be taught from the synthetic approach of using science knowledge, not as blocks of this or that science, but as tools by means of which thought edifices are builded. Even young children under the guidance of a skillful teacher show a method and technique of thinking which comes through the use of the laboratory method. And in solving problems the teacher must learn to sit on the sidelines and let the pupils carry the ball. He must be a diagnostician, not a taskmaker. He must find the interests of his pupils and then show them how to work along the lines of these interests. Thus science for young people is synthetic, is *general*, if you please, is environmental, is social and civic in its applications. When we teachers learn the underlying values of science in our daily activities, of the value of its technique as well as its subject matter applied in the daily round of life, then will elementary science really come into her own in the school curriculum.

WATER THAT APPEARS TO FLOW UP-HILL.

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Did you ever see water that appears to flow up-hill, not having merely a backward eddying, but having a well-defined flow up-hill? There are places where, to the extent that the eye is able to judge, water does move voluntarily up-hill. In Garden Park near Canon City, Colorado, and in other places in the Rocky Mountain region, this striking illusion can be seen. In Garden Park irrigation ditches carry water to farm lands, and it is in these ditches that one can most frequently see water that appears to ascend a hill. So completely is the eye deceived that many travelers are willing to wager that the water is really climbing a hill.

In the same region is another peculiarity that is related to the water that appears to flow up-hill. A traveler stopped a geologi-

cal field worker and said, "Even though I've been running on level ground, my car pulls as though the brakes were on." The traveler was told that he was, in reality, not running on level ground but that he was climbing the gradual slope of a great hill, the Rocky Mountains.

In climbing Lookout Mountain at Golden, Colorado, one will alternately change his direction of travel; these changes in direction of travel are called "switchbacks." There are upward slopes which an automobile will climb readily in "High," and there are level stretches, seeming level, that is, which an automobile will travel only in "second." Needless to say, this phenomenon is puzzling to one strange to that section. Yet the explanation is much the same as that of the water that runs against the slope of the hill.

The principle underlying these strange features, water that seems to run up-hill and the automobile that runs easily up a hill and pulls hard on level ground, is as follows:

Garden Park is on the south-east slope of the uplift caused by the Rocky Mountains. In Garden Park region there are small backward slopes, that is, hills that slope to the north-west; these backward slopes are not nearly so great as the major slope of the country to the south-east. The irrigation ditches carry water south-east with the general slope of the country until they encounter a backward hill; then they carry the water up the backward hill with the general slope of the country, a thing which many people do not believe possible. The water is running down a huge hill while appearing to climb a small one. The grade of the backward hill is not sufficient to off-set the general slope of the country. That the water when it flows over the backward hill is really not running up-hill can be proved by the use of the level.

When a car is running in the same direction as the main general slope of the country, hills can be pulled with considerable velocity, because the automobile is running down a mountain while climbing a hill. When an automobile is running contrary to the general slope of the region, it travels over level ground as though the brakes were on. A car ascends hills against the general slope of the country by the use of much power, as the automobile is really pulling a large hill at the same time it is climbing a small hill.

THE TEACHING OF CHEMISTRY.

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APPARATUS NEEDED FOR GENERAL SCIENCE.

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The students in the summer session of the University of Wisconsin who were members of the class in "The Teaching of General Science" undertook the study of what apparatus was needed for General Science. There were four principal reasons for making the study:

1. To help teachers determine the relative importance of certain types of apparatus and supplies.

2. To help select wisely the apparatus they should buy with the limited funds available.

3. To help select the most important apparatus or the most widely used apparatus to begin with, while the less important pieces of apparatus might be added as a need for them was felt.

4. To eliminate the possibility of purchasing apparatus that might not be used later on account of changes in teachers or textbooks.

The list of apparatus and supplies needed for general science was determined by making a study of the ten most widely used textbooks. A record was made of the kinds and quantities of supplies called for by each book as well as the number of times each piece of apparatus was to be used. For example, one book called for test tubes six times, while another used them forty-five times. All of the books called for the use of test tubes at least six times. Again, all of the books found some use for thermometers. The least number of times used was twice for one book, while another book used them fourteen times. The air pump was required by all books, while only seven called for barometers.

[1]Read at the November, 1925, meeting of the C. A. S. & M. I. held at Chicago.

Among the chemicals, table salt was most in demand, being required by all books. Three books used it only once while another called for it eleven times.

For convenience in arranging the results, the complete list of apparatus was separated into three general groups; viz., laboratory apparatus, demonstration apparatus, and chemicals and supplies. If any piece of apparatus was not asked for by at least three books, it was eliminated as being non-essential. Two of the books used sodium peroxide in making oxygen, while eight used potassium chlorate and manganese dioxide. Sodium peroxide, therefore, is not mentioned in the list of chemicals and supplies because it is not as generally used as is a mixture of potassium chlorate and manganese dioxide. Many substitutions may be made in the same way.

The importance of any item in the lists of apparatus and supplies may be judged by its position. In other words, a piece of apparatus at the beginning of the list is more important than one found farther down on the list. Two factors were taken into consideration in determining the proper position of any piece of apparatus—the number of books calling for that piece of apparatus, and the total number of times called for by all of the books. For example, the use of test tubes was required by all textbooks, with 143 as the total number of times used. Test tubes are placed at the head of the list. Glass tubing comes next on the list, while down near the end of the list will be found mirrors which were required by only four books and used a total of only 9 times. The same arrangement of items in descending order according to importance was carried out in the lists of demonstration apparatus and chemicals.

The apparatus and materials specified is sufficient for a class of twenty-five pupils for a year's work. In some of the experiments it will be necessary for two pupils to work together. The prices listed are taken from the most recent catalogues (1925). If there are two or three classes or sections of general science, it would still be possible for all of the classes to use the same apparatus. It would only be necessary to purchase extra quantities of breakable material and chemicals consumed. If there were more sections than one teacher could possibly handle, it would still be possible for them to use the same apparatus as it would not be necessary for all of them to perform laboratory work on the same day.

It must be kept in mind that this is not a minimum list, but a

maximum list. It is possible to perform all of the laboratory exercises, demonstrations and special problems demanded by ten of our most widely used textbooks, which for all practical purposes might as well be considered the complete list for general science. The complete cost of this equipment for one class of 25 pupils is approximately $350.00. The apparatus selected is of good quality with a generous allowance being made for breakage and the use of chemicals and supplies. If all of the apparatus was purchased at one time, it probably could be secured at a lower figure than the one mentioned above.

LABORATORY APPARATUS

Apparatus	No. Needed	Cost
(a) Test Tubes, pyrex (for combustion and ignition purposes 16 mm. diam.)	15	$1.50
(b) Test Tubes, soft glass, 6 x ⅝ inch	120	2.40
Test Tube Brushes (For large test tubes)	15	1.50
Glass tubing 6 mm	15 lbs.	10.50
Rubber tubing ⅜ in. (For glass tubing)	48 ft.	3.36
Rubber tubing ¼ in. (For Bunsen Burner)	48 ft.	9.60
Rubber tubing 3-32″ thick (Diam. ⅛-¼)	3 ft.	.75
Bunsen Burners	15	6.25
Files, triangular 5 inch	12	1.20
Bottle, wide mouth (4 oz.)	15	1.40
Bottles, wide mouth (8 oz.)	15	1.91
Beakers, 100 cc. (Pyrex)	30	7.20
Beakers, 250 cc. (Pyrex)	6	1.50
Rubber stoppers No. 1, one hole	2 doz.	1.00
Rubber stoppers No. 3, two hole	2 doz.	1.12
Rubber stoppers No. 3, two hole	2 doz.	1.48
Rubber stoppers No. 7, two hole	2 doz.	2.88
Rubber stoppers assorted (8-13)	1 doz.	3.54
Ringstand (5 x 8 Base)	15	8.25
Ringstand rings	15	2.25
Ringstand clamps	15	3.30
Flasks, Erlenmeyer 125 cc. (Pyrex)	24	4.80
Dry Cells	15	6.65
Thermometers Comb. Centigrade and F.	12	12.00
Funnels 50 mm	15	4.05
Funnels (Thistle Tube)	15	1.80
Bar Magnets	7	3.15
Horseshoe Magnets	8	2.80
Copper Wire (insulated) No. 22	1 lb.	1.71
Copper Wire (insulated) No. 30	1 lb.	3.81
Measuring sticks (meter-inches)	18	9.00
Push Buttons	2	.24
Enlarging glasses	12	10.80
Scales—Harvard trip balance	1	9.00
Weights 1-500 grams	6 sets	13.50
Evaporating Dishes 3 in.	15	6.75
Electric Bells	12	3.75
Single Pulleys	15	3.75
Double Pulleys	10	4.00
Lenses (Double convex 1 x 8 in.)	12	6.00
Prisms (3 in.)	4	2.40
Compass (10 mm. Diameter)	15	4.20
Forceps	15	1.50
Test Tube Holders	15	2.25

Petrii dishes (¾ in. diameter)	12 pr.	3.60
Mirror plane 10 x 10 cm.	12	2.40
Mirror convex 4 cm.	5	6.00
Wire gauze (5 in. square)	12	1.70
Corks—Nos. 1-26, Assorted sizes	2 gross	2.80
Total		$204.30

Demonstration Apparatus

Apparatus	No. Needed	Cost
Air pump (suction and compression combined)	1	$15.00
Air pump plate—8 in. diam. with stopcock	1	5.50
Bell jar—7 in. diam. with stopcock	1	4.00
Mercurial Barometer Tubing	1	.40
Aneroid Barometer	1	6.00
Tuning forks—unmounted C′ E′ G′ C″	1 set	1.60
Microscope	1	47.00
Force pump—glass	1	1.20
Lift pump—blass	1	1.10
Distilling Apparatus (U Tubes)	6	1.80
Cork borers—set of 6 (⅛ to ¾)	1 set	1.00
Hygrometer—Wet and dry thermometers	2	4.00
Electrolysis apparatus	1 set	4.00
Electric motor (St. Louis type)	1	3.50
Graduate 50 cc	5	2.50
Graduate 250 cc	1	.60
Steam Engine	1	5.00
Total		$104.20

Suggested, but Not Essential

Ammeter, direct current, Range 0 to 25 amp	1	$1.00
Voltmeter—0 to 10 volts	1	2.00
Aspirator	1	2.00
Telegraph set—sounder and key together	1	3.25
Resistance 4-Ohms	1	4.25
Relay—20 Ohms	1	2.00
Aquarium, Glass jar		
Total		$ 14.50

Chemicals and Supplies

Candles	2 doz.	$.20
Rubber sheet	3 sheets	
Table salt	1 box	.10
Alcohol, grain	½ gal.	.70
Alcohol, wood	1 gal.	1.35
Sulphuric acid	18 lbs.	2.00
Hydrochloric acid	6 lbs.	1.00
Nitric acid	7 lbs.	1.75
Mercury	5 lbs.	6.75
Potassium chlorate	1 lb.	.30
Manganese dioxide	1 lb.	.20
Zinc	1 lb.	.25
Starch	4 lbs.	.40
Limestone	1 lb.	.25
Iron filings	1 lb.	.15
Iodine	4 oz.	1.00
Ammonia water		.25
Litmus paper, red, blue	1 bottle each	.30
Filter paper	6 packages	.90
Sulphur	1 lb.	.60
Ether, sulphuric	1 lb.	.50

Baking soda	1 package	.10
Paraffin	1 lb.	.30
Lime water		
Phosphorus	4 oz.	.45
Carbon totrachloride	1 lb.	.40
Copper filings	1 lb.	.50
Granulated tin	1 lb.	1.00
Lead	sheet ½ sq. ft.	.30
Aluminum	sheet ½ sq. ft.	.65
Silver Nitrate	4 oz.	2.80
Turpentine	1 lb.	.40
Ammonium nitrate	1 lb.	.50
Cream of Tartar	1 lb.	.55
Copper sulphate	5 lbs.	.70
Sodium hydroxide	2 lbs.	.70
Rochelle salt	1 lb.	.40
Borax	1 lb.	.25
Total		$ 28.95

TOTALS

Laboratory Apparatus	$204.30
Demonstration Apparatus	104.20
Demonstration Apparatus suggested, not essential	14.50
Chemicals and Supplies	28.95
	$351.95

List of Practical Apparatus that may be collected at small expense:

Bells, batteries, push buttons and connecting wires.
Electric sockets and bulbs.
Pocket ammeter
Kitchen lift pump
Water motor
Flat iron
Fireless cooker
Meters, gas, electric, water, etc.
Small sewing machine
Telephone receivers and transmitters
Electric heating apparatus
Resistance wire
Vacuum cleaners
Spark plugs
Induction coils
Transformer
Air pumps
Scientific toys
An old alarm clock
Camera
Pulley, block and tackle
Screw faucet
Electric motor
Thermos bottle
Toy steam engines
Automobile jack
Projectors
Hygrometers
Toy telescope
Carburetor
Storage batteries
Dynamo
Toy gas engine
Differential gears

OBJECTIVES OF NATURAL SCIENCE.

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(Concluded from December, 1925).

Mr. Philpine Crecelius sent out a questionnaire consisting of a list of science objectives to 250 teachers of general science asking the teacher to give what he deemed the most important of the objectives. His concluding statement in regard to the results of the investigation is as follows: "I should like to conclude this report by naming five objectives based upon the results of this study and my own convictions on the subject. The following statements each of which can be elaborated as far as may be necessary to meet specific conditions seem to me to be the most valuable:

1. To acquaint the student with the elementary laws of nature necessary for the maintenance of his own and community's health.

2. To give the student an understanding and an appreciation of natural laws and their scientific application to civic problems to the end that he may become an intelligent citizen.

3. To give the student a comprehensive, general survey of the field of science that he may have a broad view of the scientific facts and principles which affect his life.

4. To give the student training in ideals and habits of accuracy, open-mindedness, and honesty.

5. To give the student a year of science teaching that will prove to be as worth while an educative experience for the one who will never study science again, as it is for the student who intends to pursue the subject for years."[6]

The first list of objectives is much superior to the second. Yet both lists may be improved to a high degree and in many ways. The greatest fault of the objectives as stated is that they are not sufficiently definite and particular. They aim at vague training which it is hoped will help make the child a better citizen, a more healthful individual, give him a so-called disciplinary training, a touch of culture, a character worth while and so on. All the objectives must be stated in terms so clear that every one connected directly and indirectly with the educational processes involved in Natural Science instruction

[6] A Report on Objectives of General Science Teaching. School Science and Mathematics, April, 1923.

can clearly understand them; so that every one can by an impartial judgment determine whether or not a given course in Natural Science or a given teacher of Natural Science is efficiently attaining those objectives.

Without going into the theory and future practice of stating educational objectives in terms of activities which should be performed by the average adult, I shall select from such a prepared list of activities, those for which in my judgment Natural Science should train the general student. The statement of the activities is taken from the list of activities given in the report of "Curriculum Construction in Los Angeles."

A course in Natural Science should enable the student to attain the "Social Intercommunication" objectives by giving him a training in the following abilities:

1. Ability to read with proper ease, speed, and comprehension.
2. Ability to pronounce one's words properly.
3. Ability to write with proper legibility, ease and speed.
4. Ability to spell words of one's vocabulary.
6. Ability to use English which is grammatically correct.
7. Ability through language effectively to construct or reproduce one's experiences and pass them on to others.
12. Ability to gain information readily and easily from the oral presentation of others.
13. Ability to present one's thought orally to an audience.
17. Ability to get the essential thought of books or articles quickly with a minimum amount of reading.
18. Ability to prepare an outline, brief, or summary of a lecture, articles, chapter, or book.
19. Ability to locate in the library the material on any topic.
20. Ability to understand and follow directions.
25. Ability to read and interpret facts expressed by commonly used types of graphs, diagrams, and statistical tables.
26. Ability to express facts by means of graphs, diagrams, and statistical tables.
27. Ability to read maps.
28. Ability to read drawings which present visually the plans or designs of things.
29. Ability to draw plans for expressing visually one's thought.

It may seem to the English teacher that the teacher of Natural Science will do a great part of her work. It is altogether right and proper that such a condition should exist. A great amount of time spent in the formal study of English upon the work dealing with the ability to express one's thoughts might be spent in the science courses with a much greater profit. The student learns to do only by doing. He will learn much more efficiently to prepare an outline, brief, or summary of an article upon some subject connected with his science course than upon some subject selected by his English teacher with the sole purpose of providing a given quantity of material for him to write

about. So with the other abilities. More of our training for social intercommunication must be given in subjects not concerned directly with formal English or grammar. Let the student receive his training for the ability to reconstruct or reproduce his experiences and to pass them on to others, to present his thoughts orally to an audience, etc., by doing such work through the presentation of experiments worked out by himself in the laboratory and reports of field trips made in his community. Opportunity for such training is present in every branch of Natural Science.

It is not assumed that courses in Natural Sciences alone provide the opportunity for such training. History, Social Studies, Foreign Language, Mathematics, offer the same possibilities but each from a different point of approach.

In respect to the development and maintenance of one's physical powers, Natural Science should help care for the following abilities:

106. Ability to make one's food contribute in maximum measure to one's physical well-being.
107. Ability to keep the bodily mechanism properly oxygenated.
110. Ability to engage in a variety of unspecialized productive labors which contribute diverse and needed elements to one's repertory of physical experiences.
113. Ability to make one's various mental and emotional states and acitivities contribute in maximum degree to one's personal well-being.
116. Ability to protect one's self from micro-organisms; and to deal with them and their products effectively in case of attack.
117. Ability to take proper precautions against spread of disease in cases of illness in the household.
118. Ability rightly to control the factors involved in the maintenance of body temperatures.
119. Ability to dress in ways that promote the physical well-being in maximum degree.
120. Ability to maintian personal cleanliness.
121. Ability to provide the most favorable conditions for the elimination from the tissues, organs, and body in general of all harmful or needless substances or agents.
122. Ability to control one's relation to sunlight so as to secure maximum benefits therefrom.
127. Ability to draw up an individual program of work, play, rest, sleep, meals, etc., best suited to one's physical nature and capacity; and currently to keep it adapted to the ever-changing conditions of one's situation.
129. Ability to protect one's self from preventable accidents.
130. Ability to deal with conditions produced by many kinds of accidents.
131. Ability to protect from smoke, dust, noxious gases, etc.
132. Ability to care for the teeth.
133. Ability to care for the eyes.
134. Ability to care for the nose, ear, and throat.
135. Ability to avoid or to prevent the conditions which bring on or sustain colds.
136. Ability to keep the heart and blood vessels in normal working condition.

137. Ability to care for the skin.
138. Ability to care for the hair and scalp.
139. Ability to care for the nails.
140. Ability to care properly for the feet.
141. Ability to control sex-functions in the interest of physical and social well-being.
142. The ability to keep reasonably well informed, in the degree to be expected of a layman, as to the discoveries of science in the fields of health conservation and promotion.
143. Ability alone or in cooperation with medical specialists to deal effectively with many kinds of disorders.
144. Ability to care for the sick—so far as laymen should have this ability.
145. Ability to take the protective precautionary, or remedial steps necessary to protect one's self or family from a considerable number of common ailments.
146. Ability to recognize the symtoms of common ailments in their incipient stages.
147. Ability wisely to utilize the services of specialists in health and physical upbuilding and maintenance.
148. Ability within one's occupational field to cooperate effectively in providing wholesome working conditions.
149. Ability to perform one's civic function in cooperating with and in the social support and control of all public agencies engaged in promoting the general physical welfare.

Most of the training for the above abilities should be given in the course of Anatomy, Biology, Physiology, and Hygiene. The other abilities listed in "Curriculum Construction in Los Angeles" may best be cared for by the Physical Training Department working in conjunction with the Science department.

In respect to the "Unspecialized Practical Labors" I believe a complete Natural Science course should care for the following abilities, some in entirety, others in part.

201. The cleaning, lubricating, and replacing worn or broken parts in lamps, bicycles, typewriters, stoves, automobiles, percolators, locks, wagons, cream separators, windmills, sewing machines, guns, door-bells, lawn mowers, harness, oft times involving disassembling and reassembling.
202. Ability to use all common kinds of measuring deivces: measures of length, area, volume, weight, temperatures, time, etc.
206. Care of paints, varnishes, brushes, oils, etc., so as to prevent deterioration.
211. Keeping in proper order and operating a gas engine.
241. Renewing the washers or other worn parts in the water faucets.
242. Proper care of the plumbing fixtures in the house.
243. Ability to operate hot-water heaters.
244. Drainage of sediment from hot-water tank.
245. The operation of furnace, boiler, stove, or whatever means is employed for supplying the original heat of the house.
246. Regulation of the mechanism of proper ventilation of the house.
248. Protection of the house against burglary.
252. The making of a fire-less cooker.
254. The making and mending of toys.
261. The care of an oil stove, including putting in wicks.
262. Renewing gas mantles, burners, etc.
263. Adjusting the gas and air mixtures in the gas range and regulating maximum height.
264. Keeping clocks wound and regulated and protected from dust and gases.

265. The care of musical instruments: piano, phonograph, etc.
270. Building a fire in a cook stove, furnace, or out of doors on a camping expedition.
271. Ability to judge the suitability of home sites of different types and locations.
272. Ability to read architectural plans.
273. Ability to plan a house in its general arrangements.
274. Ability to choose the decorations of rooms, wall paper, draperies, pictures, rugs, furniture, etc., so that the whole will comply with the principles of household design.
282. Preparing fuel, kindling, etc., for household use.
283. Ability to shut off the city water in the house and to drain the pipes whenever necessary.
300. Operation and care of the electrical lighting system of the house.
301. The ability to cut off the electric current from the house by means of the proper switch.
302. Ability to renew burnt out fuse plugs in the electric wiring system.
303. Ability to renew worn out brushes in household electric motors.
304. Ability to join wires and otherwise repair broken electric circuits.
305. Operation, adjustment, lubrication, simple repair, etc., of household electric applicances: Electric iron, washing machine, fan, toaster, heater, vacuum cleaner, sewing machine, telephone, etc.
306. The care of electric batteries.
307. Keeping door bells in proper order.
308. Ability to connect up and use a reducer in the operating of special types of ornamental lights, toy-motors, etc.
309. Ability to read the electric meter.
310. Ability to locate the difficulty when any portion of the electric system goes wrong.
311. The ability to operate and deal with the various electrical appliances, wiring, and connections without danger of accident or shock.
312. Ability to insulate electric wires.
320. Ability to operate a fire-extinguisher.
323. Safeguarding of matches, electric wiring, flues, and other places where fires may start.
324. Special care of gasoline, kerosene, gas, and other easily inflammable materials.
325. Care and proper storage of coal and wood to prevent fires.
326. Extermination of rats and mice.
328. Careful regulation of all heating, lighting, and cooking mechanisms at night or during absence, in view of safety.
329. Ability to judge the carrying-capacity of household wiring in relation to overloading and fire hazard.
330. Planting and care of lawns.
331. The care of the vegetable garden: preparing the soil, planting, cultivating, watering, protecting from weeds, insects, fungi, etc., harvesting, storing, etc.
332. The planting and care of flowers, trees, shrubs, ornamental plants, etc.
333. Ability to plan landscape effects in accordance with the principles of design.
334. Ability to arrange ornamental plants in accordance with the principles of design.
335. Planting and cultivation of fruit trees, vines, small fruits, etc.
336. Transplanting small plants.
337. Spraying of shrubs, trees, garden plants, etc.
338. Making trellises for vines, grape arbors, etc.
339. The irrigation.
340. Picking, packing, storing, etc., of fruits.
341. The selection, curing, and saving of garden seeds.
342. Seed testing.
343. Making and using a hot bed.

344. Making and caring for a cold frame.
345. Trimming a hedge.
346. Caring for potted flowers and plants.
347. The destruction of weeds and weed-seeds on property for which one is responsible.
348. The care of insect-destroying wild birds.
349. Using the lawn mower.
350. Care and repair of garden hose.
351. Conservation and compositing of leaves, lawn clippings, etc.
352. Protection of one's property from erosion.
359. Ability to keep that portion of the landscape for which one is responsible attractive to the eye.
360. Doing one's part in keeping street, alley, road, etc., clean and sanitary.
361. The control of smoke for which one is responsible.
362. The elimination of breeding places of flies, mosquitoes, and vermin of every sort upon premises for which one is responsible.
367. Cleaning and repairing wells and cisterns.
369. The destruction and prevention of animal parasites that prey on plants.
370. Constructing and placing home play-ground equipment.
371. Cutting flowers and arranging for decorative purposes.
370. The care of poultry.
371. The care of an incubator.
372. Care of hares and rabbits.
373. The care of pets of various kinds.
374. The care of horses.
375. Care and milking of a cow.
376. Care of sheep or goats.
377. The care of pigs.
378. The care of bees.
381. Ability to care for a motor car: Lubrication, making adjustments, cleaning, renewing accessible worn parts, mending and changing tires, etc.
386. Amateur photography.
388. The operation and care of a motor boat.
394. Observing traffic regulations and all rules of the road.
396. Ability and disposition to aid in conservation of forests and other national resources with which one comes in contact.
403. Ability to care for, adjust, and operate in all desirable ways an improved type of sewing machine.
425. Ability to renovate old and faded garments by dyeing.
429. Storage of clothes during the summer for protection from moths.
432. Ability to choose clothing suitable to occasion, weather, and health.
435. Ability to select shoes that are satisfactory from the standpoints of hygiene, appearance, and appropriateness to use.
440. Ability to plan meals of the maximum amount of dietary value, palatability, and ease of preparation.
446. Preparing food for sick.
448. Ability to choose a well balanced meal in a public eating place.
449. Preservation and care of perishable foods.
450. Ability to sterilize foods.
452. Ability to use leavening agents: physical, chemical, biological.
453. The care of milk following the milking.
454. Pasteurizing milk.
459. The canning and preserving of fruits and vegetables.
463. Ability to regulate a gas oven and secure the required heat.
464. Ability to use thermometer in food preparation.
466. Ability to use a fire-less cooker.
484. Ability to use an electric washing machine, to keep it oiled, to renew parts worn out.
485. Ability to care for a laundry and its equipment with a minimum expenditure of time and energy.

490. Ability to prepare material for dyeing and to dye material.
497. Keeping the dust down as much as possible when sweeping.
499. Keeping the bath-tub and lavatory clean.
500. Keeping the silver and other metal ware properly cleaned and polished.
501. Proper care and cleaning of cut glass.
502. Removing stains from clothing, floors, furniture, etc.
503. Ability to take out stains, grease, ink spots.
504. The ability to choose a soap or other cleansing agent which is the best agent for the work in hand.
505. The making of washing fluids.
506. Ability to keep all the mechanical applicances of the home clean and in good working condition.
510. Keeping the air of the home clean, pure, and of proper temperature.
511. Control of dust.
512. Sanitary care of sinks, toilets, and lavatories.
513. Extermination and prevention of house flies, cockroaches, rats, mice, and bedbugs.
514. The care of the refrigerator and perishable food supply.
515. Keeping the basement properly cooled, ventilated, and cleaned.
516. Protecting drinking water, milk, etc., from possibility of contamination.
517. Sanitary care of the garbage.
518. Utilizing the sanitary properties and value of sunlight.
519. Proper fumigation and precaution in preventing the spread of contagious diseases.
530. Care of the nails: manicuring, etc.
531. Care of the hair: arranging, brushing, shampooing, etc.
532. Care of the teeth.
533. Care of the skin.
534. Simple massaging, etc.
535. Shaving.
536. Keeping razor in order.
537. Keeping toilet articles in order.
565. Marketing of farm or garden produce.
570. Checking household purchases for accuracy in weight and measure.
571. Checking up the reading of the meters for gas, water, electricity, etc., in connection in payment of bills.
574. Ability to sell or dispose profitably of one's automobile, horse, house, garden produce, or other products of the home.
575. Ability to determine the probable cost of operation of any gas or electric appliance in the house.

The abilities mentioned in the above list should be cared for by practically all the branches of Natural Science. The abilities pertaining to health, sanitation, etc., should be cared for by the departments of Anatomy, Biology, Physiology, and Hygiene. Abilities numbering 300-312 by the department of Physics, and so on through the entire list.

As this paper deals with only the abilities required by the individual irrespective of his vocation, those abilities dealing with special occupations are omitted.

In respect to the activities of the "Efficient Citizen" I believe the Natural Science course should provide training for the following abilities;

620. The possession of a vivid and active citizenship consciousness, or large group consciousness, which looks primarily to the general welfare of community, state, nation, and family of nations.

623. Ability to read the character and measure the extent of one's social obligations and duties in the amount and character of things done for one by other individuals, groups, and agencies.

624. Ability to read and measure one's individual rights in the quantity of one's service to the general group. Ability to read one's right as things earned.

625. The ability to employ facts so effectively that injustice cannot be done where facts are clear; and so that inefficiency cannot persist where the facts are clear.

629. Ability to protect one's self from social, economic, and political fallacies, illusions, misrepresentations, petty-mindedness, fragmentary-mindedness, etc.

635. An understanding and appreciation of the social-service labors and sacrifices which have brought our institutions and social procedures to their present high levels of development.

In respect to the "Activities Involved in One's General Social Relationships and Behavior" I believe that to a certain extent training is provided in various science courses for all the abilities listed under the title "General Social Contacts and Relationships." Children pursuing a study of Biology or Nature Study, as in the case of School Gardening, in the Physics or Chemistry Laboratory work will to a certain extent acquire the abilities mentioned above. Yet I can not state, with much enthusiasm, that the instructor should have in mind these abilities as he thinks of the objectives of his science instruction.

In respect to the "Leisure Occupation, Recreations, Amusements, etc.," courses in Natural Science should care for the following abilities:

801. Ability, disposition, and habit of diversified observation of men and things and affairs as an enjoyable and fruitful occupation.

802. Ability, disposition, and habit of abundant and greatly diversified reading as a means of enjoyable and fruitful indirect observation of men, things, and affairs, and of vicarious participation in those affairs.

803. Ability through reading to enter into the serious thought-life of the world.

804. Ability and disposition to participate in a large number of unspecialized practical activities, as enjoyable and fruitful spare-time occupations.

805. Ability to utilize conversation as a profitable and enjoyable means of participating socially in the thought of the world.

806. Ability and disposition to give expression to one's experiences in participation, observation, reading, travel, in proper ways and under proper circumstances.

807. Ability and disposition to turn over in mind in quiet thought or meditation one's experiences.

808. Ability to participate in the more formal public discussions of matters of current interest.

809. Ability and disposition to utilize lectures as a means of widening one's thought by entering into the thought of others.

810. Ability, disposition, and habit of taking up occasionally the systematic study of some new thing in which one is interested.

811. Ability profitably to utilize the participative and observational opportunites of travel.
812. Ability to use the out-door life of nature as a source of recreation for both mind and body.
834. Motoring.

In respect to the "Development and Maintenance of One's Mental Efficiency" Natural Science courses should provide training for the following abilities:

901. A proportioned intellectual apprehension, such as one's natural capacity will permit, of the fundamental realities which make up the world of man's life. Awakened interests in, and tendencies to, attention to these realities. Normal appreciations and emotional reactions. The realitites include:

(a) The nature of man.
(b) Nature of man's geographical habitat, and his distribution and relations and reactions therein.
(f) The genesis of man, his nature, his habitat, institutions, modes of action, etc. A broad and rich historical mindedness.
(g) The world of plant life.
(h) The world of animal life.
(i) The world of chemical phenomena.
(j) The world of physical phenomena.
(k) The geological world.
(l) The astronomical world.
(m) The world of number and quantity.
(n) The world of form, color, visual art. A mind enriched with the great visual art of the world.
(o) World of sound and music. A mind enriched with the world's great music.
(p) World of language and of literature. A mind enriched through the reading of the great literature of the world.
(q) The world of technology.
(r) The world in composite forms: hills, woods, mountain streams, lakes, oceans, farms, cities, etc.

902. In each of the fields a sense of proportion; and sensitiveness to disproportion, distortion, incogruity, falsity, incompleteness, fragmentariness, etc.
904. Ability to do one's own thinking.
906. Ability throughout life, according to one's native capacity, to engage with pleasure and profit in a varied repertory of intellectual activities of play type for the sake of maintenance of ones' mental integrity and virility.
909. Ability to lay out for one's self and hold to a program which, considering all circumstances and conditions, promises maximum benefits in the development and maintenance of one's mental life.
913. Ability to take the protective, precautionary, or remedial steps necessary to protect one's self or family from the various causes of needless mental inefficiency or disability.
914. Ability to keep reasonably well informed, in the degree to be expected of a layman, as to the discoveries of science in the field of development and maintenance of mental efficiency.
916. The disposition always in whatever circumstance to do one's best; to hold to high ideals and standards.
917. A general dislike of things cheap, careless, and tawdry; the disposition and the habit of greatly valuing and holding to the best.
919. A philosophy of life which is, so far as possible, grounded in science—physical, biological, psychological, and social.

Notwithstanding the warnings, pleas, and doctrines of the Honorable William Jennings Bryan and various members of his tribe, I feel that Science has an important place in the religious attitudes and activities of every individual. I believe that a complete course in Natural Science should care for at least the following attitudes and activities:

1001. A sense of the brotherhood of man. A full sense of membership in the large or total social group. Large-group consciousness. A sense of human interdependency, of community of nature, of origin, of vicissitudes, and of destiny. The tendencies to action and reaction that are inherent in the large-group consciousness.

1002. Sense of oneness with humanity as a whole, present, past, and future. Sense of one's own generation in the long interlinked series of generations. A widened large-group consciousness that looks backward and forward. Tendencies to social action in response to this widened large-group consciousness.

1003. Ability to see one's environment, both the social and intra-social, sub species aeternitatis, as a vast and restless sea of forces and phenomena, infinite in number, extent, subtlety, and complexity, Ability to see and realize one's one-ness with this environment. An abiding sense of one-ness with and within the infinite order of things and forces which make up reality. (The vision provided by science—physical, biological, psychological, social.)

1004. A sense of the rights of others and of one's duty to others which is inherent in the large-group consciousness and vision.

1005. Equally a sense of one's own rights and duties which are inherent in the large-group consciousness and vision.

1006. A sense of the dignity of man—of one's self and others which springs from one's vision of the numberless forces and influences which converge upon each individual and which radiate out from him. (Vision provided by history, literature, biology, etc.)

1007. A proper humility which grows out of a recognition of one's relative powerlessness within one's self, and of one's full and continual dependence upon one's physical and social milieu.

1008. Ability, habit, and disposition to follow the leadership of the world's men of vision.

1009. Ability to catch for one's self such glimpses as are permitted to finite vision of the Being which actuates the universe as revealed in natural manifestations, in living creatures, in mankind, in man's highest examples in the record of man's thought and action and aspiration as presented in history, literature, art, science, philosophy, and in man's religious literatures.

1010. A sense of personal security, of confidence in the future, of confidence in the unseen post-mundane portions of one's existence, and a cheerful acquiescense in the order of things, which springs from a sense of one-ness with and within a cosmic whole of infinite power, of complete order and obedience to law, and apparently of benevolent purposes for mankind in proportion as man actively seeks to conform to the spirit of the whole, and to its laws.

1011. The maintenance to a life-long wonder in the presence of the limitless phenomena through the midst of which passes the orbit of man's life.

In respect to the "Parental Activities" the courses in Natural Science should provide for the following abilities in addition to those previously mentioned:

1101. The physical qualities necessary for parenthood of desirable type.
1102. The mental, moral, and social qualities necessary for parenthood or proper character.
1104. Ability to read, as fully as conditions permit, the potential characteristics and abilities of one's children.
1105. Ability to particularize the abilities and personal characteristics which should be aimed at in the up-bringing of one's children.
1107. Ability, and in large part to initiate the choice of the experiences which their children should have in order to attain the characteristics and abilities proper for them.
1109. Ability to judge, and in large part, independently to choose, the material opportunities and conditions to be provided the children for their experiences.
1112. Ability to provide the proper parental share of the personal, social, and moral influences necessary to the right up-bringing of children.

I realize that even with the objectives listed in the manner used in this paper, there still remains a certain vague notion as to the objectives of Science in respect to the individual courses. What should be the objectives of Physics, of Chemistry, of Biology, and of each of the other subjects? That question remains an unanswered one in this paper. To answer it each division of Natural Science should be treated in a manner similar to that used for the entire collection of subjects given under the title of Natural Science.

Some may maintain that all the objectives listed in this paper do not properly belong to Science. I believe that Herbert Spencer's statement that Sciences could provide the materials for the entire curriculum contains a great element of truth in it. It is my opinion that all the subjects found in our present secondary educational systems could be combined into a sort of "project-method" course with Sciences as the nuculeus of the course. The training now given in our schools is far below its potential efficiency because of the lack of coordination among the different subjects taught. The list of objectives as given above show the vast possibilities for the proper kind of co-ordination.

HOW TO GET A CLOSER RELATIONSHIP BETWEEN THE CHEMISTRY OF THE HIGH SCHOOL AND COLLEGE.[1]

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The establishment of a coordination of high school and college courses so that the latter may follow the former without discontinuity and in some cases without the sort of repetition that would be fatal is being developed more and more. The question of a closer relationship between the high school and college is an interesting one and very important. From the standpoint of chemistry as well as of other subjects close cooperation between high school teachers and college instructors is very essential for the benefit derived from this cooperation is mutual. Other factors involved in answering this question are the eagerness of the teacher to become thoroughly trained and master of his subject so that methods of presentation may be the very best possible under the prevailing conditions; and the ability of the teacher to create an interest in the subject with the intention of building up a strong background. How to get a closer relationship between the chemistry of the high school and college must be looked at from the standpoint of the college as well as from that of the high school.

Chemistry is a subject beyond the conception of a large number of students when they first enter into the study of it. Our objective in teaching chemistry is to give to the student a true knowledge of matter and in what ways and under what conditions it changes. The elementary principles which are fundamental must be taught thoroughly and then the applications of chemistry to every day life.

A student who has caught the true meaning of chemistry during his high school course frequently believes that he has already learned chemistry, and when in college may start in by slighting his work, especially if the college gives him much repetition of his high school course.

With standardized courses and common standards this repetition, which dulls the chemical interest, could be avoided and the student's interest would not wane. A well developed course, standardized equipment and a capable teacher are factors very essential in creating a closer relationship between the high school and college.

[1]Read before its Chemistry Section of the High School Conference of the University of Illinois with its affiliated School of Urbana, November 24, 1925.

The high school course must be so outlined that it fits the needs of students who do not go to college as well as for those who do. In every phase of high school work the teacher must strive to produce some degree of judgment in students' minds. Necessarily, accomplishment will often fall far short of this aim in the high school, yet no teacher will fail to attempt it. If this training alone is given by the teaching of chemistry, then we shall not have labored in vain even in the case of students whose formal education ends with their high school days.

The chemistry course given at Decatur high school, Decatur, Illinois, is organized in that way. The elementary principles which are fundamental are included mainly in the first semester's work. These fundamentals involve the gas law, the atomic and molecular theory, weight relations, valence, formulas, equations, classification of elements and compounds into metals, non-metals, acids, bases, and salts.

Chemical calculations from equations and many other but not too many problems are involved.

The applications of the elementary principles are brought out more during the second semester. During the second semester the girls, who so desire, may enroll in a class the purpose of which is a study of the application of chemistry in the household.

The fundamental things however, are presented to all classes in the same manner. In any of the three courses the student is thoroughly trained in the elementary principles which are to be a basis for further work, should he continue his work in college.

To get a closer relationship between the chemistry of high school and college, several questions must be answered.

Is the high school graduate helped toward his work in college chemistry?

What does the college demand in chemistry that the average high school cannot give?

Does the college recognize what is done in high school chemistry, both in smaller and larger schools?

Are college classes in chemistry I divided so that students have had chemistry in high school are segregated from those who have not?

To what extent do colleges segregate students?

Upon what basis is segregation made?

What are the fundamental things to be brought out in high school chemistry?

Should high school chemistry be merely informational?

Should high school chemistry involve much mathematics and quantitative experiments?

Are high school teachers merely to create interest?

A questionnaire made up of eight of the above questions was sent out to twenty Universities and colleges. The list included the Universities of Chicago, Indiana, Iowa, Kansas, Kentucky, Michigan, Minnesota, Missouri, Washington, Nebraska, Columbia, Cincinnati, Lehigh, Tennessee, Virginia, Wisconsin, Purdue, Illinois, Wabash college, Iowa State college.

Thirteen replies have been received, and the results bring to light the extent to which this question of a closer relationship between the chemistry of the high school and college is being considered.

I have summarized the answers to the questions below.

The eight questions making up the questionnaire are as follows:

(1) *Is the high school graduate helped toward his work in college chemistry?*

Twelve answered *yes*, one answered *no*.

The affirmative answer however is based upon the method of instruction in the high school.

(2) *What does the college demand in chemistry that the average high school cannot give?*

Eleven answered *nothing*.

Laboratory work with standard solutions, a series of lecture room experiments executed with skill and properly conducted laboratory work, with periods of sufficient length, were other answers received.

It is true that the large high schools have an advantage over the smaller schools in the way of equipment; nevertheless, the fundamental facts in chemistry can be as thoroughly and clearly explained in the smaller schools as in the larger. The teacher's knowledge of the subject, his aggressiveness and ability to present material clearly are requisites sufficient to teach the subject pretty thoroughly even though with meager equipment.

(3) *Does the college recognize what is done in high school chemistry?*

To this question eleven answered *yes*, one answered *no*.

Recognition of the work done in high school depends largely upon the students' high school training.

(4) *Do you have chemistry I classes divided so that students having had chemistry in high school are segregated from those who do not?*

Ten answered *yes*, three answered *no*.

The methods of segregation differ, however. As examples, I have listed a few.

At Columbia students who have had a year's course in high school chemistry take college chemistry known as 3-4. Those who have not had high school chemistry take a half year course known in Columbia University as chemistry A, and then in 3-4.

At the University of Missouri a division of the students was made over a period of ten years, but was recently abandoned in favor of the following: Students with one year high school chemistry may enter the work of the second term directly, or take the first term's work for four hours' credit (normal credit being five hours), or take the lectures (three per week) and conferences (one for two hours' credit). About one-third of their students go into the second term's work directly.

At the University of Kansas, students are given the same courses of lectures in inorganic chemistry but are assigned to different recitation and laboratory sections.

The University of Wisconsin, knowing the high school work to be good gives the students having had high school chemistry, advanced laboratory work.

At Millikin University, students with high school chemistry are placed in one class. Much stress is placed upon the development of the student's mathematical ability and knowledge of the fundamental laws of chemistry. The laboratory work during the first semester is largely quantitative. The second semester is devoted to qualitative analysis.

(5) *What are the fundamental things to be brought out in high school chemistry that will be of help to students taking up chemistry in college?*

I have listed all the fundamentals that were sent in, in answering the above question. However, all agree on four or five fundamental things.

The elementary principles, as gas laws, weight relations, properties of the more usual elements and compounds, are essential. A student should have a clear notion of the nature of matter and of chemical changes.

A knowledge of valence, formulas, equations, chemical arithmetic, molecular theory and its application, chemical equilibrium, reversible reactions, ionization and electrolysis should be developed.

Habits of accuracy, correct statements of definitions, carefulness in observation must be encouraged.

A thorough laboratory drill and drill in answering questions are very essential. The greatest weakness is the student's lack of positiveness in what he knows.

(6) *Should high school chemistry be merely informational?*

All answered *no.*

No doubt, much general information should be given for the benefit of not only those who are going to college, but particularly for those who are not.

The high school boy or girl is an impressionable person. He or she wants to know *why.* The course should include illustrations of familiar things to stimulate interest. Mere information does not prepare a student for a second course in general chemistry in the University. Information and description are absolutely necessary. Mere information does not answer *why.*

A student's scientific curiosity should be encouraged. Stimulate interest and results are bound to follow.

(7) *Should high school chemistry involve much mathematics and quantitative experiments to involve mathematics?*

Not too much mathematics and a few elementary quantitative experiments would summarize the answers received.

Since the ordinary chemical calculations are merely problems in applied arithmetic involving simple proportions, drill in this line should be encouraged. Too much mathematics will destroy a student's interest. The high school is not the place for highly refined quantitative experiments.

(8) *Are high school teachers merely to create interest in the subject?*

Twelve answers were negative. One answer in the affirmative. This was "*yes,*" providing the instruction included science in general.

The world will not pay for mere interest in a subject, but only for definite information. Interest is essential, but not the sole aim. If a teacher's purpose is to create interest only, I believe he ceases to be a teacher. Avoid too much information, otherwise the objective of self thinking is destroyed.

Students that do not go to college should get a grasp of the nature of chemistry, its methods, and its applications; those proceeding to college should get the fundamental notions well developed.

In conclusion, I should say that the results of the questionnaire

show that the colleges are recognizing the work that is being done in high school chemistry. A closer relationship means that thorough methods of presenting the subject to high school students must be developed so that they will have learned to think and know the true meaning of chemistry and its application.

The student so trained may continue the study of the subject in college with little repetition apart from students who have not had chemistry in high school.

A thorough training in the fundamentals gives the college a basis for building courses which will hold the enthusiasm and interest of such well-trained students.

SCIENCE TESTS; THE NEW TYPE VERSUS THE OLD TYPE.

By Leighton K. Smith,

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Since our school promotions and our methods of judging results both in class room and laboratory depend upon tests of one type or another, I believe that it would pay us as teachers of an exact subject to examine the different methods of testing. Surely as individuals trained in methods of science we must go about this problem in the same manner as we would attack a problem in the laboratory, that means we must look for the truth and put aside our prejudgments. The most casual investigation, I believe, will show that the old type test is far from accurate, therefore unscientific. Truth and accuracy should be the corner stone of any science, therefore why should not the same corner stone be included in judging the results obtained by our students. Most science teachers have kept pace with the marvelous advance of our subject as far as subject matter is concerned, but too large a number are too far behind in the methods employed in testing results.

Our methods of measurements in the past, and in too many cases in the present, have been extremely subjective and contain very little of the objective element. Our judgment of a student's work has been based largely on oral and written examination. Is there not too big a possibility of the method being subject to extreme variation? Let us look, for a moment, at the oral quiz. We as teachers, in oral quiz, give hints, offer suggestions, give leading questions, change the tone of our voice, perform certain facial gymnastics and finally after our various maneuvers,

extract some sort of a reply which we term a recitation. Do you really believe that with such a method we can really form any accurate judgment of what the student does or does not know? Interaction of personalities is bound to occur, resulting in underestimate or overestimate of the achievements of our students. Does not the physical appearance of the student, his interest genuine or false, his attitude in class and laboratory, go a long way in influencing our judgment of his work? (Illustration W. H. S.) These factors should not influence our judgment of the student's intellectual achievements. Does not our judgment of the student's replies to the oral quiz have too great a chance to be affected by irrevelant factors to be placed on a true scientific basis?

Let us turn to the formal written test. Does hand writing have any connection with knowledge? It should not, however, compare the attitude of mind which you have when correcting a paper neatly written with one poorly written. The old type test does not pay enough attention to the correct relation in relative importance or arrangement of our questions. Do you attempt to equalize the importance or the difficulty of different items embraced in each question? (Illustration—H_2O_2; hydrolysis).

Too many times, for the sake of convenience in marking, each part of a question is rated at the same numerical value. Take the following question: (a) Give the formula and chemical properties of H_2O_2. (b) Explain, with the aid of illustrations and chemical equations, the term hydrolysis. Surely, the second part of the question (b) should receive more credit than part (a); does not part (b) require more chemical reasoning than part (a). How many times do we as teachers give such questions equal credit; I fear far too many times.

Our questions require too much pure memory and too little thought. Our students spend too much time in writing and not enough time in thinking. We are familiar with the fact that there are large variations in teachers' marks of the same student in the same subject on the same examination. The variation is practically never less than 5% and is often as much as 15%. It has been shown that the same teacher scoring a set of papers on several different days will vary as much as 30% on the scores allowed to a given paper. An objective or new type test would eliminate these difficulties.

The old type written test does have one outstanding redeeming

value which I believe the new type test does not have, that is, it teaches the student to organize his material. This organization of material must take place from a question giving no direct hint as to the answer. Take this new type question, for example:—Substances which hasten a chemical action without themselves being permanently decomposed are called catalysts, electrolytes, allotrops, colloids. One of the terms is not only defined but placed before the student. I have found that many students underscoring the correct word in the new type test would be somewhat at sea in answering to the same degree of satisfaction the same question stated thus: Discuss catalytic action and give an example. The man of the world does not have the answers to his problems thrown before him as illustrated in the new type question; instead, the problems of life are more like the conditions as found in the questions of the old type.

The new type tests are objective, are arranged to measure some definite trait or degree of achievement. By objective is meant such a test as can be scored by any one of normal intelligence, thus removing any reacting of personalties due to the scorer's personal knowledge of the individual who did the test. This requires that the questions be of such a nature as to require very definite and exact answer, therefore, the scoring can not depend upon judgment or any of the subjective elements of the one doing the scoring. Marks will have a more definite meaning; forty correct replies out of fifty possible replies certainly has a more definite meaning than A or B when it is derived by methods which I have shown have great possibility for inaccuracy to enter.

These tests are usually constructed upon judgment of the group, surely average judgment has a greater value than individual judgment. The mechanics of these tests are simple. The student has only to underline or to write a word or phrase, or to put a cross in the correct place.

I cite the following experiment to prove this point. The writer selected two sections in chemistry, the one section received a ten minute new type test each day, the other section did not receive such a test, when the old type test was given to both sections, the section receiving the daily new type test did far better work in the old type test.

Some of our better known objective tests have median scores computed from large number of pupils, thus it makes it possible to compare one city system with another, one class with another,

one section of the country with another, one teacher's work with another teacher in the same system. These tests furnish an excellent means of experimentation for discovering the answers to such questions as best methods of presentation of subject matter, order of studying the different parts of a subject, proper size of class for a given unit of work, for purpose of establishing standards of achievements.

I have already stated one objection. There are others, such as the expense item as each pupil must have printed form of test. Should the questions not be selected in most careful manner, the poor student will make a high score. The unit of thought is probably too short. These tests, however, have many valuable points and the results may be used to aid us in a scientific way to grade our students as well as give us information to aid us in improving our work. One warning: Many a blessing has become a curse. A recent investigatior in giving these tests in chemistry in 42 different schools published as one of his conclusions the following statement:—"that a large proportion of text-book material means little or nothing to 50% or more of the students, who studied one of these text books in a high school for one year." Compare that conclusion with a statement of Dr. Blanchard of Mass. Institute of Technology who says—"that the instruction in high schools is good is evidenced by the fact that the young men who almost every September take and pass with high rating our entrance examination for advance standing. Although a student may have forgotten his chemistry during the summer so that he could never pass an examination, nevertheless it is astonishing how the background of chemistry he has acquired helps him to comprehend what we have to offer." We must be on our guard or the school administrator looking for means of financial reduction will attempt to reduce work in science by misinterpretation of these results. This would be a wrong use of these tests. There is no doubt that similar tests in the other subjects would disclose the same so-called startling conditions. These results should be used as a means of correcting and improving science teaching and not as a means of retrenchment of science work. These tests, I believe, have passed through enough experimental stages to show that their strong points more than counter balance their weak points. The conservative, progressive teacher surely will avail himself of their use and by a combination of the two types be able to arrive at a more accurate conclusion of results obtained by students.

PUBLIC HEALTH EDUCATION IN RETROSPECT.[1]

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When King Tut reigned in Egypt the male sex married at 13 or 14 and the girls at 12. This was necessary in order for the parties concerned to enjoy an appreciable period of conjugal existence because the life span was exceedingly short in those ancient days. King Tut himself died a very young man.

At the time when Queen Elizabeth graced the British throne a man who survived thirty summers of that stirring romantic age was no less an exception to the general rule than the centenarian is today.

As late as 1800 the average length of human life was less than 25 years but if had risen to 45 by the opening of the twentieth century. Now, in the United States, a child at birth, if he can be identified as that illusive character, the average person, may look forward to an after existence of 58 years on this earth.

The law of cause and effect has operated to bring about tnis marvelous transformation whereby the years of man are not only extended to more than double their former number but are made infinitely more healthy and happy. As one authority expresses it, "In twenty-four years we have accomplished more in medicine than in twenty-four centuries before.

The change that has taken place has been both negative and positive in character. Quackery and the sale of nostrums in their worst forms have been eliminated while the advancement in medical and sanitary knowledge has been accompanied by the development of public and private agencies devoted to the purpose of controlling and preventing diseases.

To understand of what moment are the things that have transpired during the past fifty years one needs but to give a hasty glance at the history of the Illinois State Department of Public Health and dwell for an instant upon a few outstanding features of that history.

In 1877, not yet 50 years ago, the Illinois State Board of Health was created by an act of the legislature. Commenting on that event, which was certainly a manifestation of public concern in matters of health, the Chicago Tribune, on Nov. 21, 1877, said:

"The State Board of Health is of recent invention. The last Legislature, in its infinite wisdom, saw fit to create this new board. By some it has been thought to be an unnecessary luxury

[1]Read before the Illinois State Academy of Science, Springfield, Ill., April, 1925.

and by others an actual necessity. One of its principal duties is to obtain a registry of all the physicians in the state who are entitled to practice and who are graduates of medical colleges, and to issue to them a certificate showing that they have either passed the necessary examination, or shown ample proof that they are physicians in good standing, entitled to the sheepskins which they profess to own. So far, the Board is a benefit to the public, and it will materially aid in wiping out the quacks, who have settled themselves all over the State."

From the December 17, 1877, edition of the Inter-Ocean, a Chicago daily, is the following extract:

"It is hardly necessary to say that the city of Chicago has become noted, not only for the immense number of villianous quacks, but for the ignorant and imperfect manner in which the register of births and deaths has been kept. The infant who was reported as having died of 'canker rash, diphtheria, dysentery and consumption,' and another, whose cause of death was returned as 'five doctors,' doubtless had good reasons to die; and 'delicate from birth,' 'infancy', 'stopage', 'fits', 'colerafantum', 'collocinphanton', 'cholry fanton', 'bled', (diarrhea) 'billirm (delirium) fever', 'artry lung busted', 'feusson' (effusion), 'canker on brane', and 'Infermation lungs', probably convey some ideas to persons who wrote the terms; but such returns cannot be of much use from a statistical point of view. The importance of correct and intelligent registration cannot be underestimated, as modern sanitary science owes its existence to the registration of deaths and the localization thereby of insanitary conditions. It is right that the enforcement of the two bills, passed by the Legislature of the State, that will make such a radical change both in medical profession and in the method of registering births and deaths, should demand considerable attention."

These quotations suggest the deplorable conditions into which the practice of medicine had fallen fifty years ago in Illinois. Anybody who desired to become a "doctor" had only to open an office, hang out his shingle and bid for clients. There was none to hinder him and his success depended only upon his ability to attract patients. Short course and fake medical institutions sprung up and flourished. In many quarters the business of making and being "doctors" was looked upon as a lucrative vocation rather than as a high and dignified calling to a noble service for the alleviation and prevention of human ills.

Of course the quack is still with us but he is more refined and fairly well regulated. His range of mischief is more limited. He cannot prescribe drugs. He must secure a state license. The public understand that the term "doctor" does not necessarily imply "M. D." Most folks know to whom they must turn when real medical advice or service is desired.

Other Service of the Board of Health.

Serious as it was the "quack" problem made up but a part of the duties ascribed to the State Board of Health. Epidemic and pestilential diseases stalked to and fro in the land. The Board of Health was required and given authority to employ whatever measures were deemed necessary in the abatement and prevention of such diseases. Section 2 of the original law of 1877 reads, in part, as follows:

"The State Board of Health shall have the general supervision of the interests of the health and lives of the people of the State. They shall have supreme authority in matters of quarantine, and may declare and enforce quarantine when none exists, and may modify or relax quarantine when it has been established. The board shall have authority to make such rules and regulations and such sanitary investigations as they may from time to time deem necessary for the preservation and improvement of the public health, and they are impowered to regulate the transportation of the remains of deceased persons."

Under this provision the Board of Health, during the second year of its existence, was called upon to deal with a terrifying epidemic of yellow fever. During the summer of 1878 the disease broke out in New Orleans. This was no uncommon occurrence but the outbreak suddenly assumed such serious and fatal proportions that the population fled from New Orleans like rats from a burning vessel. The refugees were unwelcomed guests in Northern territory. The disease soon began to work its way up the Mississippi valley and to appear in the same deadly form among the inhabitants of the river towns. Like some invisible beast it crept from town to town reaching its terrible fangs into the homes of both rich and poor, striking terror into the hearts of everyone. Whole cities were depopulated over-night except for the sick and the courageous doctors and nurses who ministered to their needs. The diesase travelled as far north as Cairo, Illinois, where it caused scores of cases of illness and resulted in 62 fatalities.

The following quotation from the August 14, 1878, edition of the Chicago Times, indicates the frightful state of affairs that prevailed in Grenada, Mississippi:

"There have been seven deaths from fever and eight new cases in the last twenty-four hours. The indications are that at least eight or ten more will die before noon to-morrow. So far, none have got well. The town is in a filthy condition. The sewers are open in many places, and garbage lies around uncovered. Disinfectants are now freely used. At least five hundred white people, out of a population of twelve hundred white citizens, have left town. They are certainly not to be blamed. Only one colored person has been taken down so far. It appears to strike the best citizens of the place. Dr. Hughes reports four cases of black vomit that will die to-night undoubtedly. The weather is very unfavorable for the patients. It is cloudy and threatening rain. All excepting the drug stores are closed. No train is allowed to stop and supplies are getting scarce. The condition of affairs here is truly appalling."

Another newspaper dispatch, quoted from the August 16, 1878, issue of the Chicago Tribune sheds more light upon the distress at Grenada. It was a copy of a telegram to the Mayor of Wilmington, N. C., and reads as follows: "Grenada, Miss., Aug. 14, 1878.—To the Mayor of Wilmington: Help us to pay nurses and bury the dead. Our town is a graveyard. We need help. The Mayor is dying, and I am the only officer left.—E. D. A. Molton, City Marshall, Acting Mayor."

Conditions were much the same in Memphis while in New Orleans every ordinary social and business activity was completely demoralized if not entirely paralyzed.

People of Illinois were in a state of alarm lest the yellow fever plague should fasten itself upon the state. Chicago newspapers carried the harrowing details of the epidemic under such compelling head lines as:

JUNGLE JACK
His Summer Tour in the North
to be opposed at Every Step.

THE FANGS OF FEVER
Fastened on Two More Dwellers
in Cincinnati Yesterday.

NEARING THE NORTH
The Yellow Fever's Progress Up
the Mississippi Valley
Unimpeded.

THE AWFUL ARCHER
His Victims Still Falling by the
District.

THE DENS OF DEATH
Railway Trains Unchecked in
Their Flight Past the
Plague Spot.

THE MOWER OF MEN
Progress of Yellow Jack's Harvest
of Humanity at the
South.

Nobody in the whole Mississippi Valley or in territory contiguous to the Gulf coast felt safe from yellow fever. Nobody knew how the deadly plague was spread so that everyone stood in constant fear and dread of every person and everything that came from the fever district. Everything was suspected of harboring the germs of the dreadful disease that had already worked such havoc in the main foci of infection. As indicative of the state of knowledge about the cause of yellow fever the paragraph from instructions sent out by the Surgeon General of the U. S. Public Health Service is quoted. As they appeared in the August 20, 1878, edition of the Chicago Times, we read:

"The weight of scientific evidence seems to warrant the conclusion that yellow fever is produced by an invisible poison, capable of self-multiplication outside of the human organism, which it enters through the air passages. The poison germ or miasm is a product of the tropics. In this country yellow fever has prevailed in most of the Gulf and Atlantic cities, and in many of the towns along the Mississippi river. In some instances it has been carried inland with the people fleeing from infected localities, but it has never shown a disposition to spread epidemically at points remote from the continuous water-roads of commerce, or to lodge in high, salubrious places. The cities of the great lakes have always been free from the disease. Yellow fever cannot be said to be epidemic in the United States, from the fact that in some years it does not appear, though the imported germs undoubtedly survive the mild winters.

It appears to have about as much resistance of cold as the banana plant. When the banana stalk is killed down by the frost the yellow fever does not recur again until imported. The

germ is transmissible. It is capable of being transported to the clothing or personal affects of passengers and sailors, but its spread from one city to another is chiefly accomplished by vessels, their damp, filthy holds and bilge water being its favorite lurking-places. Confinement, moisture, and high temperature favor the multiplication or virulence of the poison."

People looked with suspicion upon the earth, vegetation, the sunshine and the air. This is demonstrated by the following paragraph from the Cairo (Illinois) Bulletin, dated August 2, 1878:

"Great care should be taken not to root up vegetable matter, or uncover heaps of mould, or remove pavements during this season. These are the lurking places of bacteria, vibriones, and fungi. It is safer to apply the antiseptics to them as they are than to expose their miasmatic underlying to the sun."

A similar slant is evidenced from the minutes of the meetings of the State Board of Health. From a chapter of those official records relating to the proposed inauguration of a most exhaustive sanitary and drainage campaign we read:

"In such study there must, of necessity, be a careful and thorough consideration of measures that will prevent not only the periodic over-flows which occur almost every year, sowing the seeds of disease and death throughout the entire lower country, but of measures that will go yet further, and, through a comprehensive, skillfully planned system of drainage, will make dry the swamps and marshy places, and reclaim the millions of acres of valuable land that today remain more or less submerged as they were left by the aborigines, giving off continually noxious gases which, in their effects, are annually consigning thousands to premature graves, and at the same time placing the health of the whole people upon a lower plane than it would otherwise occupy, diminishing thereby their powers of resisting disease and enabling epidemics, as a consequence, to count their victims in greater numbers."

Even railroad cars and boats were regarded as carriers of yellow fever. So firmly were pullman cars suspected that the State Board of Health took measures not only to require the most thorough disinfection of cars that came from the epidemic districts but to prohibit them from entering Illinois at all. In the course of investigating pullman cars a report from the superintendent of the Louisville and Nashville Railroad lines was received and incorporated in the minutes of the Board meeting. It reads, in part, as follows:

"In contracting our lines as the disease manifested itself in Memphis and other points south, in the latter part of July and the early part of August all lines whose northern termini were in this city (Louisville) were entirely withdrawn, and thenceforward, until after the Board of Health had declared it safe for citizens to return to Memphis, not a single sleeping car coming from an infected district came into this city; the cars on the line from New Orleans to Cincinnati passed around the city by the short line cut-off, leaving the main stem of the Louisville and Nashville railroads three miles south of the city."

Another idea of how yellow fever spread north from New Orleans is gained from a dispatch which appeared in the August 15, 1878, edition of the Chicago Tribune. This conviction explains why refugees from the infected cities spread fear and alarm among the people in communities to which they fled. The dispatch reads:

"It is now definitely known that the fever was communicated to the Mississippi towns in the clothing of a boatman of the first boat that stopped at Memphis. This is one of the most dangerous means of spreading diseases, as well persons fleeing to the Northern cities can readily carry the poison."

Another newspaper quotation, describing the public alarm created by the appearance of a case of yellow fever in Cincinnati, gives a vivid picture of the state of the public mind in regard to that disease. The dispatch is taken from the August 1, 1878, edition of the Chicago Times and reads:

"Last Saturday morning a couple of guests registered at the Grand hotel as 'William Hines and wife, New Orleans, Louisiana.' They were just from the train, and the gentleman, who, as it was afterward learned, is a very wealthy cotton broker, of the Crescent city appeared very ill. The lady, a most beautiful woman of perhaps 35 years, appeared to be very nervous and ill at ease, and it was plain to be seen that her condition arose from her solicitude for the welfare of her husband. In response to their request, the best apartment in the hotel was assigned them, and as quickly as possible the gentleman was placed in bed, and a physician summoned. Dr. Reamy, whose office is directly opposite the hotel, was soon at the bedside of the patient, but he found considerable difficulty in diagnosing the disease that he was called upon to grapple with. The wife, however, afforded him light on the subject without hesitation, saying that she was positive that Mr. Hines was a victim of that terrible scourge now

raging with such virulence in New Orleans, Vicksburg, and other southern cities, yellow fever. Dr. Reamy was disposed to doubt the truth of her assertion but Mrs. Hines declared her conviction that it was yellow fever and nothing else; that she had been afflicted with the disease herself, and that while at home they had been exposed to it, and their presence at this time in Cincinnati was due to the fact that they came north with the especial purpose of getting beyond its reach.

"Finally other physicians were called in, among them Dr. Tom Minor, the health officer. The result of this consultation was that it was a clear and pronounced case of the fell disease, though not what might be called a 'bad case.' Of course Col. Gilmour, the proprietor of the Grand, was not long in finding out that he had beneath his roof a man afflicted with a disorder as much to be feared and dreaded as is the smallpox, and, as a matter of course, he was in a fever of excitement. The news spread in some inexplicable way, and it was not many hours until a sort of panic reigned, where a few short hours before all was ease and enjoyment. Dr. Minor saw at once that his duty was to remove the patient to the city hospital, and this he at once made arrangements to do. Going to the hospital he explained the case to Col. Jones, the superintendent, and that official was horror-stricken at the idea of admitting within his door a victim of the scourge. He protested against it with vehemence, but after a great deal of persuasion and not a little plain language on the part of the health officer he finally gave in."

The extent to which fear of yellow fever found lodgment is indicated by quarantine regulations adopted against that disease. Subsequent to the epidemic in New Orleans that city adopted regulations which included:

"In the event of any cases of fever breaking out in the city from germs hibernating from the last epidemic, each case will be kept under strict surveillance, and ingress and egress from the house where such case occurs will be prevented by a cordon of sanitary police, so as to prevent the spread of the disease."

A national board of health was created which drew up a most far reaching plan for sanitary control, including drainage, of great areas along the Mississippi Valley and for an interstate sanitary police system which would be clothed with great power. In behalf of this plan the president of the Illinois State Board of Health made an eloquent plea, closing with the impressive statement:

"Then will be dispelled, and then only, this deadly malaria which ever hangs like a heavy cloud over the entire Mississippi Valley, acting as a great clog to the energies of its inhabitants, and undermining the constitutions of all."

In connection with the yellow fever epidemic of 1878 the Illinois Board of Health was very active. It kept sanitary and medical officers at Cairo constantly. It participated in all the interstate activities of importance which had a bearing upon the situation. It established quarantine regulations that required the inspection of all transportation equipment that came into the state from the south, including river boats. It worked untiringly and was responsible for controlling and allaying much of the alarm that smoldered in the minds of the whole population.

Other Diseases.

Yellow fever was not, of course, the only disease that ravaged upon the public and indeed it was not the chief one in Illinois. It merely held the center of the state for some years immediately following the creation of the Illinois Board of Health. Typhoid fever, tuberculosis, diphtheria, smallpox, scarlet fever were all far more deadly and far more prevalent in the state than yellow fever ever was.

As if prophetic of what was about to happen in Chicago, the Inter-Ocean carried in the December 19, 1877, issue, a long discussion of the danger to that city from smallpox. In the course of the discussion it pointed out what had already occurred elsewhere, which, one may believe was sad enough, judging from the excerpt that reads:

"To show what the result of these deficiencies in the health department of Milwaukee have resulted in, it may be stated that during the past two years that city, with only a population of 80,000, has had nearly 5,000 cases of smallpox, 700 of which resulted in death, The city has at last arrived at some sense of its condition and it is now constructing a temporary smallpox hospital as fast as it can be built. In Montreal, a city not much over one-third as large as Chicago, and which, also, has no smallpox hospital and no compulsory vaccination law, the death rate from smallpox averaged 700 per annum."

A year later a most deadly and devastating epidemic of smallpox broke out in Chicago. It reached it crest in 1881 and raged on through 1882 causing 1180 deaths the first and 1292 deaths during the second of these two years. The death rate per 100,000

population from smallpox mounted to 218 and 230 for the two years respectively. Doubtless conditions were but little better in much of the down-state territory, although there are no statistics to bear out this assumption.

Eight years later in 1890, Chicago found itself in the throws of a typhoid fever epidemic of major propositions. It raged relentlessly for three long years causing 1008, 1997 and 1489 deaths during 1890, 1891 and 1892 respectively. This situation caused no such alarm and terrorism as an outbreak of yellow fever because typhoid was always present and these three unhappy years were merely worse than usual.

Examples like these could be multiplied at length both in regard to the diseases named and in regard to others such as diphtheria, scarlet fever, tuberculosis, rabies. The story would be all the more tragic if statistics were available for the entire state.

Contrast the foregoing with present day conditions. No case of yellow fever has been reported in the United States for a number of years. If the disease were to appear, and it is still a potential danger to the southern states, no wide-spread alarm would result because speedy measures for absolute control would be promptly introduced.

The 1923 death rate from smallpox in Illinois was less than 1-10 of 1 per 100,000. There were only 1450 cases of typhoid fever with less than 300 deaths in Illinois last year. The general death rate was 11.2 per 1000.

The change has resulted from a widening of real scientific medical knowledge. High School boys today know more about medical and sanitary facts than did practitioners of the healing at 100 years ago.

On the other hand there is still a long way to go. Diphtheria is a positively preventable disease. Toxin-antitoxin will make children immune to it. Why then do we still suffer therefrom? An average of more than 10,000 cases are reported annually to the state health authorities; an average of 1000 per year terminate fatally. The simple truth is that parents have not yet believed in their hearts that toxin-antitoxin is less dangerous than diphtheria.

Tuberculosis is still a problem. Pneumonia is just as deadly as it ever was. Mortality from heart diseases and cancer has increased. All of these maladies are subject to preventive and control measures. Progress toward preventing these and other diseases depends more largely upon the dissemination and popular application of scientific medical knowledge already available than upon the results of further researches in this field.

A QUESTION AND ANSWER METHOD OF WRITING PHYSICS EXPERIMENTS.

By Hallie Turner,

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That the aim in performing a particular experiment in physics is too often lost sight of by the student is an indisputable fact, it is to be feared. The majority of students in most of our high schools perform their experiments with the idea of "getting it done." How seldom does a student stop and think—"Now, what am I doing this for?" In the usual methods adopted in schools a manual is used with the procedure described in great detail and two or three questions or a problem given as the conclusion. It has been the practise in many schools for the students to write-up their experiments in great detail. Many teachers still think that the student gains enough from it to compensate for the extra time used. The writer, too, held that opinion for several years. The plan was for the student to re-write the laboratory directions "in his own words." And what does that mean to the average student? It is simply revising and rearranging the words of the manual. He does no more thinking as to the reasons involved in the procedure than if he had not written it. The operation of writing it then becomes a purely mechanical one. There may be exceptions but this is speaking of the average student. The exceptions are those who would get it in spite of the method used.

The questions usually given at the end in the manual are too general and a minimum amount of thought will provide the answer. When they have performed and written the experiment according to this plan how many students can tell the teacher the reason for certain operations; why they weighed the object under water, why they wiped the ice dry etc. Invariably the answer is what? "Why, the book says to," And what has the student gained? Perhaps his English is improved, he may have learned a little of the more accurate methods used in scientific laboratory work and the procedure of that experiment may be a little more impressed on his mind. And the latter probably has no more value than that of assisting him to reproduce this method on examination, which is of small consequence.

It is usually conceded that high school science should stimulate interest in practical situations and phenomena and arouse a habit of inquiry. And the laboratory is the natural place to fulfill this aim.

It was with these thoughts in mind that the writer tried the method which is to be described, first as an experiment and then because of the satisfaction it gave to both teacher and pupils adopted it as a substitute for the more formal method of writing up experiments. Instead of having the student rewrite the method mimeographed questions were given out for each experiment. The written answers to these were then handed to the teacher together with the data sheet and graphs or other sheets required for that experiment. These questions were made out by the teacher as no manual could be found which went into the question method as detailed as was wanted. The purpose in the question was to force the student to question himself as to the reasons for the procedure used. In other words to get him to think about what he was doing.

A few sets of questions as given to the students will best illustrate the plan. These experiments are usually taken up in physics courses so were chosen here as examples.

TO FIND THE SPECIFIC HEAT OF A METAL.

1. What is meant by the specific heat of a substance?
2. Do you see any reason why it was advisable to choose the conditions so that the final temperature should be close to the temperature of the room?
3. How did you find the number of calories absorbed by the water?
4. Is some heat absorbed by the calorimeter? How did you find this amount?
5. What was the source of all this heat?
6. What relation exists between these amounts of heat? Express the equation in words.
7. Why should the metal be poured into the water immediately?
8. What advantages has a calorimeter such as you used?
9. If a pound of iron and a pound of water were both heated over a fire the same number of degrees, would they take up the same amount of heat?
10. Would a pound of aluminum or a pound of lead take up the same amount of heat as a pound of iron, if heated the same number of degrees?
11. Which would take up the most heat, which the least?
12. How could the temperature of a hot piece of iron be found, assuming it to be at a temperature higher than that registered on your thermometer?
13. 500 gms. of copper, specific heat 0.09, at a temperature of 120° C. are dropped into 500 gms. of water at 10° C. What is the final temperature of the mixture? Let it represent the final temperature, express as an algebraic equation and solve.

TO FIND THE HEAT OF VAPORIZATION.

In questions 2, 3, 4 and 5 show how the quantity was computed.

1. What is the heat of vaporization of a substance?
2. How much steam in grams was condensed to water?
3. How many calories of heat have entered the water?
4. How many calories of heat are given up by this condensed steam in cooling from 100° to the final temperature?
5. How many calories must have been given up then by the condensation of the steam?

6. Why is a steam trap used?
7. Would it have changed the result if some of the steam condensed before it reached the cold water?
8. How is this experiment related to the heat which comes from a steam radiator?
9. Explain the fact that evaporating moisture, such as perspiration or a few drops of alcohol or ether on the hand produce a cooling effect.
10. How much heat does steam give up when it condenses to water?
11. Does this bear any relation to the amount of heat water takes up when it changes to steam?
12. How many calories will it take to change 200 gm. of water at 20° C. to steam at 100° C?

A Study of the Action of Various Cells.

Voltaic.

1. When the circuit is open what occurs at each plate?
2. When circuit is closed what effect is observed?
3. What effect does amalgamating have?
4. Why?
5. What is meant by local action? How did you remedy it?
6. Why was the plate heated?
7. Was there as much current indicated after heating the plate?
8. What is the effect of drawing out and replacing the plate? Explain.
9. What is polarization?

Daniell.

1. Is this cell polarizing or non-polarizing?
2. What is deposited on the copper strip in this cell?
3. Does this explain the answer to question 1? How?

Dry Cell.

1. Is this cell polarizing?
2. Does it recover its strength after being short-circuited?
3. How does the action of this cell differ from that of the voltaic cell? Explain.
4. Which of these three cells would you use to operate a door-bell? Why?

Forces—Resultant and Equilibrant.

Paralled Forces.

1. What is an equilibrant?
2. W is the equilibrant of what two forces?
3. What single force would balance W? What is this force called?
4. What have you learned regarding
   a. The magnitude of the resultant of two parallel forces?
   b. The product of either force by its distance from the resultant?
   c. The relation between the direction of the resultant of F, and F2 and of W?
5. State a proportion which you have found to be true between the two forces and their distances.

Forces at Angle.

1. Is the sum of any two of these forces equal to, greater or less than the third force?
2. In your diagram which line is the resultant?
3. What is a resultant?

These experiments on the heat of vaporization and specific heat were chosen to show how the mathematical side was treated. It was hoped that in arriving at the answers to these questions the computation involved would be clearer and more reasonable to the student. In the usual methods he fills in the blanks in his manual with figures, multiplies when it tells him to and sub-

tracts or adds when directed, a meaningless operation. He is striving to bring from the maze a figure which resembles the answer he knows he ought to get. On the other hand after he has literally torn his procedure to pieces in answering the above questions is there any doubt but what he has had to do a little thinking and may it not perhaps open his eyes a little as to the why-ness of the operation of common things going on about him?

The experiment as carried on to find the value of this method was with four classes in physics. Two of the classes wrote up their experiments rewriting the complete method and the other two substituted the answers to the questions. The writer was well assured that the two classes using the questions made better progress and had a better understanding of their laboratory work. The students themselves voluntarily expressed the same feeling. There were several instances where members of the first two sections came to the teacher and asked if they could not use the questions. "Those in the other classes seem to understand it better," they said. At the change of semesters the method was exchanged in the four sections. In all cases those using the questions showed a better grasp of the work. The students using them showed more interest. They were doing more thinking. It was even necessary at times to quell slightly heated arguments over the laboratory work which was regarded as a healthy sign.

In this case the classes each consisted of from twenty-five to thirty students. This method proved a time saver to the teacher, although not adopted for that reason. As a student finished the experiment his numerical results were checked and his experiment, *written in the laboratory,* when completed was brought to the teacher. In a very few minutes it could be looked over, and by a few additional questions the understanding of the student tested. If necessary then he was sent back for further study. When this was done to the satisfaction of the teacher the experiment was filed in the laboratory to prevent comparison of answers between students. A new experiment was not taken until the first was accepted.

Students were allowed to progress as rapidly as their ability and the judgment of the teacher allowed. In assigning the new experiment the ability and interest of the student was considered.

As a result the writer was thoroughly convinced that those objectives of laboratory physics which are generally held to be of

first importance were fulfilled best by this method. In order to get a vision of the world of forces and physical phenomena *interest* must be aroused. After using these questions for two years results showed a much greater interest than was ever evidenced with the old plan. The question method required closer *observation* and because of the *better understanding* resulting it meant that the *practical activities of everyday life*, those of heat, electricity, mechanics, etc., would be dealt with *more effectively*.

"FLATLAND"—A SYMPOSIUM

By Walter Crosby Eells

Whitman College, Walla Walla, Washington.

Contempt, scorn, curiosity, amusement, mild approval, enthusiasm—such is the range of emotion experienced by different members of a class in mathematics upon reading "Flatland," that delightful little mathematical phantasy personifying geometrical figures as inhabitants of a two dimensional world.[1] Surely a little volume which can arouse such a variety of emotions is worthy of a place in every high school mathematical library. Unfortunately, it is now out of print, but it can still be obtained through second-hand dealers. It has been used more than once too as the basis for mathematical dramatizations for high school mathematics' clubs.[2]

The object of this paper is to report the actual reactions of a class of college freshmen to this book. This class is composed of those who are taking a single general course in mathematics as a cultural subject, not expecting to continue the subject in college. As part of their work they were given a list of supplementary reading, requiring a report and review of one of the books read. The largest number chose "Flatland" to review. Extracts from these reviews may be of interest to high school teachers and students and incidentally may arouse in some of them a desire to read the volume itself, probably with pleasure as well as profit to themselves—mathematically speaking!

But let the members of the class speak for themselves. The first quotation is from a boy who characterizes "Flatland" as a "brainstorm." "Some people have brainstorms. If these same brainstorms can be converted into money, the individual is indeed fortunate. Such is the case of some man who evidently went to sleep in a cactus plant and had a bad dream. Upon

[1]Flatland: A Romance of Many Dimensions, by A. Square. (Edwin A. Abbott.) First published in England in 1884. Republished by Little, Brown & Co., Boston, 1899.

[2]See for example, School Science and Mathematics, Vol. XIV., p. 583.

waking he made a grab for pencil and copy paper so that he might convey his dream to the paper. He attributes his finished product to 'A. Square,' not wishing his real name to be connected with the masterpiece. We can hardly blame him for this, however, for we ourselves would scarce like to have our names connected with such a conglomerated mass of mathematical hog-wash. With no apparent reason under the sun, the author dives into fields hitherto unknown and raves on and tells nothing in a great many words. The trend of thought seems to be that somewhere there is an extraordinary country called "Flatland." The people thereof are about the queerest of any known in the fertile imaginations of sane or insane. The author, Mr. Square, must have either been a confirmed bachelor, or a sour old grass widow. His treatment of the "thinner sex" as he calls them, is indeed harsh at times." But as a matter of fact the author was a married man, and had one son and one daughter.

Not much more favorable is the reaction of a girl who was careful enough to read it through twice. "The first time we read the book 'Flatland' we thought to ourself that it was probably the work of a lunatic. We read it again—the whole thing—and wondered who was the lunatic, we or the book's author, for it was evident that one or the other was. We were beginning to feel afraid that we were losing our sanity. But a happy, though selfish, thought occurred then to us, and we knew we were safe—that it was the Author, not us, who was the lunatic. We looked at the title 'Flatland' and at the author's name, 'A. Square.' Both these names were puns, or if not puns, very close approaches to them. And surely, we thought, no one would make a pun, especially such a poor one, except a lunatic."

Nor the following: "The author's purpose seems to be to try to convince us that there is such a thing as a Fourth Dimension, and at the same time to give a few digs to present customs, etc., which no doubt he thinks are very sly and exceedingly funny. He has taken a whole book to do it in, when he might just as well have given us the idea in a few words. Even in the whole 155 pages he doesn't attempt to give us an idea as to what the fourth dimension really is. Personally we like Mr. H. G. Wells' story, 'The Time Machine,' which rather vividly explains his own concept of the fourth dimension. Perhaps that is altogether wrong—we are not a good enough mathematician to tell. At least it is an Idea, and comes closer to making a point than this stupid book."

Another girl rather reluctantly admits that she liked it, although she thinks the admission rather discreditable to herself. She says: "I'm almost ashamed to admit it, but I really enjoyed reading A. Square's 'Flatland,' altho I think it is a rather foolish juggling of mathematical figures by some fevered, unbalanced imagination."

A boy who also made a second attempt received a more favorable impression than the girl quoted above after her second perusal of its contents: " 'Flatland' is another of those unique or odd books which on first examination are extremely distasteful to the reader but which, if the reader should continue, he will find to become more and more pleasant, until it becomes positively fascinating. I must confess, frankly, that had I not been required to read 'Flatland' and had I happened to pick it up, I should soon have laid it down in disgust. As a matter of fact, it was not until my second effort that I was able to become interested in the book. There is however, somewhere, somehow, hidden inside the covers of the book, an attraction that is impelling, alluring; which is slow to react, but which, when brought in full force, calls forth the utmost attention of the reader. This force can somewhat be explained by the quaint style, the utter absurdity and clever use of mathematical terms in the book, which make it doubly interesting to a mathematics student."

The next girl finds amusement in the book, but resents the author's treatment of women: "To me the book 'Flatland' is exceedingly interesting and funny. Just why the author represented the women as straight lines and why he regarded them as lower than the lowest class of workmen, I don't know. My curiosity became aroused as to the author of the book and why he had such a grudge against women, consequently I turned to the front of the book and to my astonishment found that the author was a minister. I might have expected such a book to have been wrtten by almost any type of an individual except a minister. I surely thought that if any one were broadminded it would be a minister and I assume that the reason the book was written under an assumed name was to conceal this very fact."

The author's treatment of the fair sex has quite a different effect on the next girl, who writes: "Most of us know what this world is like, but until recently we never thought of Flatland, altho now it seems to me to be almost as interesting a land as

Mars. I was very much interested in the women of this strange land. According to the author, the women are straight lines because they are devoid of brain power and have neither reflection, judgment, nor forethought, and hardly any memory! What a different attitude our land has toward the Straight Line Woman! Here she is considered very smart and envied by her sisters who are truly creatures of dimension."

Full appreciation of the imaginative elements in the book are shown in the two following quotations: " 'Flatland' was the most entrancing, imaginative book I have ever read." "Flatland! A land entered only on the wings of a mathematical imagination. It is a land where fancy is raised to the fourth power, and the square root is extracted from commonplace, prosaic minds entering therein. A fairyland of mathematics—it holds one entranced and introduces us to all-inclusive circles; important, self-centered polygons; intelligent, self-respecting equilateral triangles; sharp, dangerous soldiers with only points where brains ought to be; and last but of all importance the weaker members of Flatland, who like all their kind are very dangerous —the straight line, more commonly spoken of as woman! So a visit to Flatland, if it doesn't change us into a flat square or triangle, gives us a larger concept of the worlds of Two and Four dimensions."

The conflicting statements in the quotations above regarding authorship may be explained by stating that "Flatland" was published anonymously, the title page giving the author as "A. Square." The copy used by the class was secured at a second hand book store in Chicago. It has the name of "Daniel C. Leary" written on the fly leaf, and the following personal letter from the English historian Ball is pasted in the front.

"Trinity College, Cambridge.
"28 January, 1908.

"Dear Sir:

"Flatland was published anonymously, but I believe that no secret was ever made of the authorship and that it was acknowledged by Mr. E. A. Abbott to have been written by him. The Rev. E. A. Abbott was formerly Master of the City of London School. He has written books on the teaching of English, and latterly some on theological subjects. I am under the impression that Flatland is the only work on a scientific subject he has ever published.

"Thanks for your note on Delastille's book. I had not previously heard of it.

"I am, Yours truly, "W. W. ROUSE BALL.

"D. B. Leary, Esquire."

A few additional facts regarding the author, Rev. Edwin Abbott, the distinguished English theologian and Shakesperian scholar, may be of interest. He was born Dec. 20, 1838, and graduated at St. Johns College, Cambridge, where he took highest honors in the classical, mathematical, and theological triposes. At the early age of 26 years he was made headmaster of the city of London school, a position which he held from 1865-1889, when he retired to devote himself to literary and theological pursuits. It was during the latter years of his service at this school that he wrote "Flatland," which was published anonymously, as were some of his other works, all of which are credited to him as author in the English "Who's Who." This volume credits him with the authorship of over thirty theological works, and a dozen literary and pedagogical works. "Flatland," however, was his only venture in the field of mathematics. He married in 1863 and had one son and one daughter. He held the M. A. and D. D. degrees. As far as can be learned he is still living in England, or was in 1921.

(Author's Note: The latest edition of the English Who's Who in our library is 1916. In the publisher's index for 1918-1921, I find him given as a living author. In the necrology of the International Encyclopedia Yearbooks since that date, and of the American Review of Reviews, I find no mention of his death. I assume, therefore, that he is still living. I would appreciate it, however, if you could look him up in the latest English Who's Who, or other reference work and verify my final sentence. I feel the handicap of not having available the libraries I used to work in at Chicago. In case of his decease, kindly substitute the sentence, "He died in 192–, at the age of — years.")

Higher education in Kansas will be administered in future by a board of regents, consisting of nine persons, appointed by the governor without restriction as to political affiliation, residence, or connection with educational institutions. This plan is practically that suggested three years ago by the Bureau of Education of the Department of the Interior in its survey of higher institutions of Kansas. Previously the control of the 27 State institutions—penal, eleemosynary, and educational—has been in a board of administration, of which the governor was chairman.

An increase in the school day to six hours or longer has been made in a number of places in Massachusetts in order to give time for the necessary school subjects and for supervised study during school hours.

ARTIFICIAL SILK.

By Elizabeth Weirick,

Director of the Textile Testing Laboratory, Sears Roebuck & Company.

For many years there was very little incentive to use scientific methods or research in the Textile Field, for natural fibers were plentiful and comparatively cheap, dyes were abundant, skilled labor was easily obtained and labor costs were low. But during and since the war, all of these conditions have changed. The demand for fabrics has enormously increased while the supplies of natural fibers have decreased. The flax fields and factories of Belgium, one of the world's chief sources of fine linens, were destroyed by the war. Decreased acreage and boll weevil ravages cut the cotton production far below demand; earthquakes and government disturbances in the Far East more or less affected the silk market; thus the supplies of the common natural fibers became inconstant and too low. Then we suddenly found ourselves without dyes. Skilled labor became scarce, labor costs high, and all of these factors increased the coast of manufacture and the cost of merchandise to the consumer.

To meet these changed conditions new sources of supplies of both fibers and dyes were imperative. Here was an opportunity for the chemist and engineer, and they have met it with success. As a result, two chemical industries have been outstanding in their phenomenal development and commercial success during this period: the American Dye Industry and the Chemical Fiber or Artificial Silk Industry.

Artificial Silk or Fiber Silk, as it was formerly called, is the only synthetic fiber that has ever reached the position of competitor with the long established natural fibres, wool, silk, cotton, and flax. It now ranks third in the amount of consumption. In general appearance, that is, luster and smoothness, it is very similar to silk and often mistaken for it, but in composition and chemical properties, no relation to it. Its early history was a struggle to overcome serious deficiencies in its properties, but with patient, constant experimentation and research these are being rapidly overcome. To-day, it is standing on its own merits and although it still has some limitations it need no longer be considered a substitute or adulterant. Because this fiber has proved to be such a worthy member among fibers it has been rechristened *rayon* in order to give it its deserved indepen-

dence and to avoid confusing it with silk. This name has been officially adopted in the United States but as yet it has not been accepted by all of its manufacturers. It has been indorsed by the *Silk Association* of *Great Britain* but not by the *European Silk Congress.* This product has been and still is, wittingly and unwittingly, sold over the counter as silk, but every effort is being made to prevent it.

Silk is the solidified secretion of the larvae of certain moths which they spin about themselves to form a cocoon when changing from the larva to the pupa stage. The silk is secreted from two glands in the head and solidifies as it comes in contact with the air, thus forming smooth, parallel, cylindrical filaments. These filaments, hundreds of yards in length, are strong, pliable, elastic, and of protein composition.

Rayon fibers, in imitation of this natural process, are made by forcing heavy viscous solutions of plant cellulose through capillary openings to form soft, smooth, pliable filaments which are then solidified and purified by chemical means, collected into thread and reeled. The number and size of the filaments in a thread depend upon the number and size of spinerettes or holes in the spinning disc.

The idea of making a synthetic fiber in imitation of silk was first suggested by the French botanist and physicist, Reaumur, over one hundred and ninety years ago but was forgotten until 1884 when Count Hilaire de Chardonnet succeeded in making one by forcing collodion or nitrated cellulose through fine orifices. He patented his process but it did not reach the point of commercial production until seven years later when the first factory was erected at Besancon in northeast France. Then followed other processes of manufacture, all of which were invented and developed by Europeans.

Four distinct processes are now being used for the manufacture of rayon. They are in order of their discovery and development: the *Nitrocellulose, Cuprammonium, Viscose,* and *Cellulose Acetate.* All are similar in that they use cellulose in the form of cotton or spruce wood pulp as a base, but, as their names imply, vary in the chemicals and methods employed for dissolving and purifying it. The final product from the first three processes is regenerated cellulose; that from the fourth is cellulose acetate, a compound of cellulose, and therefore having quite different properties from the other three.

The *Nitrocellulose* process has been most extensively developed

in France and Belgium and is now being used by one company in the United States. The product is known as *Collodion* or *Artificial Tubize* Silk and is the strongest of these products. Following are the main steps in its manufacture: Cotton linters are boiled in sodium hydroxide, bleached and dried. This product is nitrated with nitric and sulphuric acids thus changed into nitrocellulose or gun cotton. After pressing, the nitrocellulose is dissolved in ether and alcohol or in alcohol and calcium chloride sufficient to form a heavy viscous liquid, which is filtered and then forced through spinneretts, emerging as fine threadlike filaments. These solidify as the solvents evaporate and are wound on bobbins. At this stage the nitrocellulose thread is very inflammable. It is therefore denitrated with ammonium sulphide or other denitrating agent, leaving the pure cellulose thread, which is thoroughly washed, bleached, and rewound. This is an expensive process due to expensive chemicals. Uniformity of denitration is very important for if incomplete the silk becomes yellow when stored and dyes unevenly.

The *Cuprammonium* process, although discovered in 1890 by the Frenchman Depeissis, was first manufactured by Pauly in Germany in 1897 and has had its major development in that country; however a plant for its manufacture is just now under construction in the United States. Because of the high prices and shortage of raw materials necessary in this process it has largely given way to the cheaper one of viscose. The product of this cuprammonium process known as *Glanzstoff*, *Pauly*, or *Bemberg* silk is made by dissolving either mercerized cotton or wood pulp in ammoniacal copper oxide thus forming an unstable blue viscous fluid of copper alkali cellulose. After filtering, the solution is spun into a coagulating bath of sodium hydroxide to precipitate the cellulose, then passed through sulphuric acid to remove the copper, after which it is bleached and reeled. This product more nearly approaches silk in fineness and luster than the other varieties and for this reason is being used in combination with silk.

The *Viscose* process produces the large portion of the world's output of rayon. It was evolved in England by Cross, Bevan and Beadle in 1892, but was not a commercial success until 1905. In this process sulphite wood pulp or cotton is mercerized with sodium hydroxide. The alkali cellulose formed is pressed to remove excess alkali, then cut into shreds or "crumb" and aged until mercerization is complete and a lowering of viscosity occurs. This

product is gradually added to carbon disulphide in which it quickly dissolves and changes to cellulose thiocarbonate or cellulose xanthate, a yellow substance. This xanthate is dissolved in dilute sodium hydroxide to from a thick viscose liquid, aged, purified, then spun into an acid bath, usually sulphuric acid which neutralizes the alkali and causes the precipitation of the cellulose filaments. The crude rayon is conditioned, reeled, washed, and baked. The sulphur thus brought to the surface is removed by treatment with hot sodium sulphide after which the rayon is bleached, dried, and transferred to winding machines. This process is in many respects more complicated than the others but is cheaper.

The *Cellulose Acetate* process was perfected by the Swiss Chemists Henri and Dreyfus and is an incidental outgrowth of the cellulose acetate industry developed for airplane dope during the war. It has only recently reached the point of commercial value under the names of *Celanese* and *Lustron*. In this process bleached cotton linters dissolved in acetic acid and acetic anhydride in the presence of a catalyst are changed to cellulose acetate. This is dissolved in sufficient acetone to form a thick viscous fluid, is spun, the filaments collected, wound on spools and dried.

Although the general processes for the manufacture of these rayons seem quite simple, they involve most intricate problems in colloidal and physical chemistry. The constant supervision of trained engineers and research chemists is essential to their development and success, also specially built equipment and intelligent labor. All of these factors require huge investments of capital. It is estimated that the minimum amount for establishing an efficient manufacturing unit is three and one-half million dollars. Last year the total investment of domestic production was reckoned at about one hundred million.

Although the rayon industry reached commercial proportions in Europe in 1900 it was eleven years later before it was of any importance in the United States, but during the last five years it has had phenomenal development here. Over one hundred companies organized, but many have fallen by the wayside from lack of the immense amount of capital necessary to develop such an industry, leaving the field to a few huge organizations. There are at present nine important manufacturers, one using the nitrocellulose process, one the cuprammonium, five viscose and two cellulose acetate. A few statistics will give an idea of the tremendous extent of this rayon industry.

	Total World Production	Domestic Production	Domestic Consumption
1911	.....	320,000 lbs.	.....
1913	28,850,000 lbs.	1,566,000 lbs.	3,872,000 lbs.
1918	35,000,000 lbs.	5,828,000 lbs.	5,949,000 lbs.
1919	40,000,000 lbs.	8,174,000 lbs.	9,246,000 lbs.
1920	50,000,000 lbs.	10,240,000 lbs.	11,720,000 lbs.
1921	65,000,000 lbs.	15,000,000 lbs.	18,276,000 lbs.
1922	81,000,000 lbs.	24,406,000 lbs.	26,522,000 lbs.
1923	108,000,000 lbs.	35,400,000 lbs.	38,429,000 lbs.
1924	141,000,000 lbs.	38,850,000 lbs.	40,804,000 lbs.
1925	*185,000,000 lbs.	*54,700,000 lbs.	
1926	.....	*74,100,000 lbs.	.....

1924 Total production of raw silk = 110,000,000 lbs.

*Estimated.

The United States has increased its portion of the world's output from 5 per cent in 1913 to 28 per cent in 1924 and is now the largest producer, England, Germany and Italy following next in line. Our manufacturers have not been able to keep pace with the demand although they have succeeded in supplying 95 per cent of the rayon consumed in this country. It has therefore been necessary to draw upon foreign sources for a small amount. Most of the foreign product is coarse, uneven, and inferior in quality as compared to that of the United States with the exception of some very fine yarns produced in Germany. Of the world production about 76 per cent is made by the viscose process, 18 per cent by the nitrocellulose, 5 per cent by the cuprammonium, and 1 per cent by the cellulose acetate. Even though its production has surpassed that of silk it is at present only about 1½ per cent that of cotton and 3½ to 4 per cent that of wool.

The reasons for the very sudden commercial success of rayon are several: First, women have advanced in art education and appreciation and are demanding lustrous fabrics of new color combinations and designs; second, rayon is a comparatively cheap fiber and its supply can be regulated; third, manufacturers are becoming more familiar with its characteristics and how to use it and are producing not only new styles of rayon fabrics but interesting and attractive combinations with wool, silk and cotton. So it is proving to be a boon to other fibers rather than a competitor.

Rayon's chief asset is its luster. When first manufactured it was harsh, stiff, coarse, brittle, and metallic in appearance. It had almost no elasticity and little strength and lost these when wet although it regained them when dry. It therefore had to be

handled with great care, and in weaving was supported by yarns of silk, cotton or wool. For these reasons its uses were greatly limited. However, science is rapidly overcoming these deficiencies. By changing the viscosity of the spinning solutions and methods of spinning, stronger, more elastic, and finer filaments are being produced. By decreasing the size of the filaments and increasing the number twisted together, yarns are now spun which are more pliable, softer in finish and feel, and which have the subdued luster of silk. Such yarns are adaptable to finer grades of fabrics and are being used for warp as well as filling. No one process seems to have the advantage over the others in all respects. For example, the cellulose nitrate variety seems to be the strongest, the cuprammonium can be spun the finest, the viscose is the most lustrous, and cellulose acetate holds its strength best when wet and is the most pliable; that is, each process lends itself to certain types of improvements better than the others with the result that each variety of rayon has some advantage and disadvantage over the others.

The cellulose acetate variety having a different chemical composition from the others has its own distinctive properties. Because it does not wet out easily and absorb water, it will not take the ordinary dyes which give such brilliant results to the cellulose varieties. This has been a great disadvantage, but recently dyes have been developed especially for this fiber which are easily applied and give beautiful colorings. This former defect is proving to be a commercial asset, for interesting cross dyeing effects are being obtained by weaving cellulose acetate with other varieties. It, like silk, is a poor conductor of heat and electricity, while the others are good ones and so it makes warmer garments and good insulating materials.

Because the fibers of rayon are smooth and solid they do not readily collect and hold dust and dirt; they wear well but crease and wrinkle easily. Recent patents indicate that rayon can be waterproofed, fireproofed and weighted like silk. It is claimed that it permits ultra violet light rays to penetrate and will therefore make desirable garments for sun bathing.

Even though the properties of rayon are being constantly improved and it is being used for practically all of the same types of fabrics as silk, it cannot yet compete with pure silk in strength, durability, and softness. As compared to silk, depending upon the variety, it is from 10 per cent to 20 per cent heavier, from ⅓ to ⅔ as strong and elastic, and has about ½ the covering

power. When wet it loses from 50 per cent to 70 percent of its strength while silk loses only about 20 per cent. This means that rayon garments should be handled with care particularly when laundered.

Rayon can readily be identified by burning it. The three cellulose varieties flash and burn quietly and quickly, emitting the odor of burning paper. Cellulose acetate melts and fuses back leaving a hard, black globule, or else it drops much like sealing wax. It has somewhat the odor of the others. Silk burns with difficulty, without flame, leaving a hard black globule similar to cellulose acetate but emits the strong, disagreeable odor like burning hair, characteristic of protein substances. Although rayon is affected by alkali it does not readily dissolve in it as does silk.

This interesting fiber is now used either alone or in combination with silk, wool, or cotton in the construction of practically every kind of garment; in dress goods, linings, underwear, hosiery, pile fabrics, ribbons, sweaters, and knitted dresses, scarfs, braids, gloves, artificial fur, embroideries, millinery fabrics, bed spreads, furniture coverings, draperies, lace, fringes, and lamp shades. It offers a wonderful opportunity for research, for although it has been greatly improved there are still many problems to be solved before it attains the limit of its usefulness.

HUGE VOLCANIC CRATERS IN ALASKA.

In exploratory work conducted under the Department of the Interior during the summer of 1925, R. H. Sargent, topographic engineer of the Geological Survey, and R. S. Knappen, geologist, discovered a remarkable crater in the southwestern part of the Alaska Peninsula that is nearly as large as the famous Crater Lake in Oregon. The work of the Geological Survey party included the mapping of a mountain some 8,000 feet high that had already been reported to be a volcano, but a closer inspection disclosed nestling in the summit of the peak a crater approximately 5 miles in diameter. The huge bowl was found partly filled with ice and snow, and numerous glaciers occur on its precipitous outer sides, radiating from the crater rim like the spokes of a great wheel. This is believed to be the highest crater in the world of like dimensions. Another crater was discovered about a mile and a half in diameter and a thousand feet deep.

The Alaska Peninsula is a region of volcanoes and craters. In 1922 Topographic Engineer Sargent and Geologist W. R. Smith discovered in the same vicinity a mammoth crater which is 6¾ miles in diameter. This crater, which was named Aniakchak, was further studied this year by Mr. Knappen and found to be far more wonderful than had been previously supposed. Many cubic miles of volcanic ash and lava cover the country within a radius of 15 miles from its center. The interior of the crater affords many interesting studies in volcanology—lava flows, ash cones, dissected volcanic necks, and warm springs, showing that Vulcan, the fire god, is not yet dead.

The Sargent-Knappen party reports much big game in the country, particularly the huge Kodiak bears, of which 54 were seen during the trip.

THE SCIENTIFIC BACKGROUND OF BAKING.[1]

By C. B. Morison,

Dean of the School of Baking, American Institute of Baking, Chicago, Illinois.

The story of bread and baking is interwoven with the social and cultural development of the race. Bread is a common metaphor for food and how to obtain bread and butter is one of the chief concerns of mankind in general. The obscure origins of baking, the conversion of raw cereal grains into baked products are lost in the prehistoric past, and the earliest reference to them are to be sought in the literature of folklore and tradition.

Primitive bread was probably made by merely soaking cereal grains in water, followed by pressing of the swollen mass into a cake and then exposing it to the heat of the sun, or to the hot ashes of the fire. Simple baked cakes of this description have been found on the site of the ancient lake dwellings of Switzerland and are still made in various parts of the world. The reduction of the grain to a coarse meal by manual methods, such as the mortar and pestle, was an important step forward and from which the origins of milling may be traced.

These primitive breads made from whole grain or coarse meal were unleavened, and it is commonly supposed that the preparation of leavened or fermented bread finds its earliest historical records in the literature of the Egyptians. The leaven used was very simple, obtained by spontaneous fermentation of a dough of ground grain and water containing wild yeasts and gas forming bacteria derived mainly from the atmosphere. A batch of dough was then inoculated with this leaven to start fermentation. A part of the leaven was reserved for use in future doughs. Similar systems of leavening doughs are still used both in this country and abroad for the preparation of various types of bread.

The art of bread making became an important industry in ancient Greece and Rome and the baking trade a recognized social factor in the welfare of the state. Bread was made under the strict supervision of Roman law, and the legal relation of bakers to the state is still continued in all civilized nations. The Roman legions carried their bakers and methods of baking into Northern Europe and our barbaric ancestors in the passage of time adopted the leavened bread of their conquerors.

[1]Read at the November, 1925, meeting of the C. A. S. & M. T. at the University of Chicago.

In medieval times the baker's guilds were powerful in civic affairs, and the production of bread under the supervision of City and State was subject to strict regulation. Bread was the chief article of the diet and in some cities of Europe the people were supplied with bread baked in a common oven. Good bread was a community necessity and so recognized by the government.

The social, political and economic relations of baking command a more extensive literature than its scientific background. It was not until the eighteenth century that we find the real beginnings of an active scientific interest in bread. While the classical and medieval natural philosophers had speculated on flour, dough, leaven and bread as they did on any thing else in nature, the baker and the miller had to wait until the new science of chemistry established by Lavoisier, and the other great men of his time, could be applied to the study of the familiar phenomena of the bakery. It is thus very interesting to note that the scientific study of baking may be said to have really begun at this period in the history of science.

In 1767, Malouin (1707-1778) a member of the Academy of Science and a Professor of Medicine in the College de France, published his "Description des arts du Meunier, due Vermicellier et du boulanger." This remarkable book was one of the influences which inspired the great French chemist Parmentier (1737-1813) to write his "Le Parfait Boulanger au Traité complet sur la fabrication et le commerce du pain," published in Paris in 1778. This was followed by other works on milling and baking by Parmentier of great value and practical interest. Parmentier summarized the knowledge of the time on wheat, its cultivation, composition and properties, milling, the blending of flour, yeasts and leaven, the mixing of dough, fermentation, effect of salt, and baking. He also realized the necessity for training bakers in breadmaking and food values and was instrumental in founding a school of baking in Paris where he delivered a most interesting address at the opening of the school in 1780 on why education in baking was needed. This school continued and prospered until the days of the French Revolution when its organization was broken down in times of public disorder when the revolutionists had no need either for schools or chemists.

Since the days of Parmentier many of the great investigators in the natural sciences, particularly in chemistry and biology have at one time or another interested themselves directly or indirectly in some of the problems relating to baking. The farmer's problem of wheat has enlisted the attention of the agronomist and the agricultural chemists. The work of the Agricultural Experiment Stations in the wheat growing states and the U. S. Department of Agriculture has been invaluable to the farmer.

In milling the old stone mill of early days has been practically replaced by the highly developed process of roller milling introduced into this country about fifty years ago, and the modern flour mill is equipped with the most ingenious machinery for reducing the wheat to flour and its by-products. The operation of a flour mill not only requires engineering ability of a high order, but the organization of the mill chemical laboratory with its staff of trained chemists engaged in control work and investigation for efficient production and uniform flour.

The modern bakery has developed from a handicraft where bread was made according to tradition with little change from its primitive beginnings to an organized industry with mechanical equipment for handling and weighing flour, and other materials, high speed mixers for mixing doughs, fermentation rooms under temperature and humidity control, automatic dividing, rounding, and molding machinery, controlled proof boxes and ovens, that make possible the large scale production of bread to satisfy the demands of an ever growing population. The sanitary requirements surrounding production are recognized so that bread in general is offered to the consumer in accordance with high standards of public and industrial hygiene.

It is therefore evident that the managing and production personnel of the modern baking industry should possess suitable training and grounding in both science and engineering. Since the baking process is fundamentally based on chemistry, biology, physics and mathematics, and their applications, courses of training for future bakers must include instruction in these subjects.

Special training equivalent to a science degree in chemistry and biology is necessary for the student who wishes to enter the baking industry as a control chemist and these courses are given in some of the universities and colleges of the wheat growing states such as Minnesota or Kansas. Basic general engineering

training is also required. There have been, however, no satisfactory courses available until recently for the student who wishes to enter the baking industry for a future position of responsibility as a shop superintendent, or production manager.

The development of a technical course of this kind requires an expensive commercial baking equipment, laboratories, and a special teaching personnel who have had not only the proper scientific and technical training but who have had a practical connection with the baking industry. Short intensive courses are required to meet the requirements of the students who in most cases come directly from the industry and who cannot afford the time or expense of long periods of instruction. At the American Institute of Baking, three short courses in baking of sixteen weeks each have been organized to meet the demand for such intensive and fundamental training. The subjects studied consist of Practical Shop Work in the Bakery, Experimental Baking Laboratory, Production Problems, General Science, Baking Materials, Chemical Laboratory Experiments, Biology of Yeast, Bacteria, Molds and Principles of Nutrition and the Food Value of Bread.

Supplementing the regular subjects of instruction, special lectures are given when the schedule permits, on the Federal and State Food Laws, Sanitary regulations, weight laws, legal relations of bakers, industrial and personal hygiene, sales problems and trade associations. Special inspection trips are offered each month to bakeries, flour mills, yeast plants, bakery equipment manufacturing plants and other points of interest to the student bakers.

The practical shop work is conducted in the completely equipped mechanical bakery of the Institute and is based exclusively on actual problems that occur in commercial practice. All students are required to spend from 30 to 32 full time days in the bakery, working on problems of formulas, fermentation, and the general and special requirements both by manual and machine methods for all types of bread and rolls. This includes a minimum of 75 hours in the dough or fermentation room and 150 hours in the other departments of the bakery. The shop work requires attendance of 90 hours on lectures, quizzes, and class room instruction, and 30 hours for special instruction in production methods according to the best commercial practice. In the last few months of the course each student must demonstrate his ability to operate and manage the Institute Bakery and

handle a regular commercial shop to the satisfaction of the instructors.

Highly important for the student is the study of various types and blends of flour for the purpose of determining their proper fermentation period and breadmaking properties. Practical experience in the solution of fermentation problems and difficulties is necessary since fermentation of the dough is perhaps the most important process problem of the baker. The work in the Experimental Bakery is based on the systematic study of a series of baking experiments on the laboratory scale organized to give the student a knowledge of the effect of the various ingredients and conditions on fermentation and the quality of the resulting bread. Each student keeps his own laboratory notes and at the end of the course has an invaluable record for future use. The experiments in this laboratory are correlated with the large scale experiments in the Institute Bakery. The solution of production problems is continued throughout the course and requires home study and the compilation of special reports.

The brief course in General Science provides the students with an elementary knowledge of chemistry, physics and biology as a basis and introduction to the subjects of Baking Materials, Chemical Laboratory Experiments and Nutrition. The lectures and discussions of the sources and properties of baking ingredients is related to the schedule of experiments in the chemical laboratory. Special emphasis is given to the biological aspects of bread making, in the instruction given in the biology of yeast, bacteria and molds.

The growing interest in nutrition and the discussion of the food value of bread and cereal grain baked products requires that these subjects be presented in the light of recent progress in this field. Facilities for this instruction are provided by the recently established nutrition laboratories of the Institute, so that material for exposition and demonstration is readily provided.

The baking course has been organized from the standpoint of the correlation of theory with practice so that the necessary emphasis on the scientific background of baking is not lost or rendered subservient to an excess of zeal for practical consideration. Such a course is also at present of great value to those graduate chemists and biologists who are preparing themselves to enter the baking industry in its control and research laboratories. While a student may be satisfactorily grounded in his

professional training at the university, a point of contact with the materials, process and product problems of the particular industry in which he is to locate is not readily obtained. In this relation the advantages of a course of instruction within the industry is of the highest value.

Another example of where special training in a school within the industry is of advantage is in the training of instructors for what has been termed vocational training. Many of our large cities have begun or are considering the advisability of the organization of part time courses in baking in their vocational schools for the young people employed in the bakeries. One of the practical difficulties here is to find the right kind of instructor, one who not only has had practical experience and a flair for teaching, but one who has also some knowledge of chemistry and biology and their application in the baking process.

The science teacher in the secondary schools will find much interesting material in the phenomena of the baking from flour and yeast to dough and bread which can be used for the purpose of demonstrating some of the familiar things of everyday life in terms of the natural sciences. A trip to a bakery with an explanation of what is going on there can be easily arranged under the auspices of your local bakery and it is not difficult to perform interesting experiments in the school laboratory to show the composition and properties of flour, yeast and bread. In all science teaching whether it be in the secondary school or the university, some point of contact with the facts of common everyday experience is essential if the student is to become really interested. Anatole France once wrote that "the whole art of teaching is only the art of awakening the natural curiosity of young minds, and curiosity itself can be vivid and wholesome only in proportion as the mind is contented and happy." If this is true, the teacher should be on the lookout for things which will stimulate this wholesome curiosity and among those very near at home are the unique biological and biochemical phenomena of the baking process and the work of those very busy chemists, known to the mycologist as Saccharomyces cerevisiae and to every one else as yeast.

Fermentation has always been a fascinating subject to inquiring minds from the very earliest times, and the mysterious frothing of fermenting liquids and the rising of dough have led to no end of interesting speculations from the days of the alchemists, followed by the experimental philosophers of the 17th

century, like Van Helmont and Stahl; by Lavoisier in the 18th, who first paved the way chemically, the great controversial period of the 19th century in which Liebig and Pasteur made biochemical history, to the enzyme conceptions of Traube and the contemporary theories of enzyme action today.

The effects of enzyme activity on a large scale are among the most striking phenomena of the bakery, and the inquiring student will also observe the swelling of colloids on a large scale, the fixing of carbon dioxide foam structure by heat and concomitant changes that are concerned with the colloidal behavior of proteins and carbohydrates, in the production of bread.

In conclusion, the scientific background of baking has been in process of development for about a century and a half and much research is still necessary before a clear and comprehensive picture of the process may be drawn. The work thus far accomplished has been the result of many hands and the facts established have made it possible for the baker to base the most efficient practice of his art on the help which has been given to him by the chemist and biologist.

STRAW MULCHING SLOWS NITRATE FORMATION IN SOILS.

The practice of mulching soils with straw slows up the process of nitrate formation, according to experimental results reported by W. A. Albrecht and R. E. Uhland of the University of Missouri.

The soil used in the experimental work consisted of a layer of top soil of brown silt loam about eight inches thick and a subsoil of rather compact clay loam. Three experimental plots of the same dimensions were laid off. One plot was given a heavy mulch in the proportion of six tons of s raw to the acre; one plot was given a mucih in the proportion of two tons per acre; the third plot was not mulched. Analysis revealed the nitrogen content of each of the three plots to be practically the same at the start of the experiment.

The plots remained for one year during which time samples were taken at intervals of two weeks to determine the progress of nitrate formation. It was found that nitrates were formed very much more slowly in the mulched plot than in the unmulched, in spite of the fact that nitrogen in the form of ammonia was present in larger quantities under the straw mulch.

The conclusion was drawn that straw mulch in applications as heavy as six tons per acre cuts down evaporation of the moisture from the soil, thereby lowering the temperature. Mulch also prevents normal exchange of air. All of these factors tend to produce a poor physical condition in the soil and unfavorable conditions for the proper formation of nitrates from the nitrogen available.

It was also found that the lighter mulch gave similar results as the heavier mulch except in a lesser degree.

The G. C. Merriam Company, Springfield, Mass., have issued a little paragraph called, "Word Study," articles on word study, which should be in the hands of every English teacher in the United States.

It is a splendid little leaflet issued to help English teachers in practically all phases of English teaching. It helps them over difficult points and is a little pamphlet that all English teachers should send for and carefully study.

BETTER HOMES IN AMERICA.

Better Homes in America is accomplishing a work for the advancement of real American citizenship as perhaps no other one organization can do. It is altogether a serious proposition that the United States has been fast getting away from the fact that the old fashion American home is fast disappearing. It is realized that not every American family can afford to own his own house and lot in a big American city. It is found where people are in a house together, in flats or apartments that the home spirit and home environment of fifty years ago is fast disappearing from our country.

Every American, insofar as it is possible, should live in a house owned by that family. A family cannot have the secrecy, exclusiveness, and freedom which tends to maintain a high morale in the home without being the possessors of a homestead where all of the surroundings are inducive for raising a family. Statistics show that where we have a city with a large proportion of family owned homes, the percentage of crime and lawlessness is not as high as it is in a center in which the people of necessity must live in flats or apartments.

It is hoped that right-minded fathers and mothers will get in touch with the National Headquarters of Better Homes in America at 1653 Pennsylvania Avenue, Washington, D. C., by sending for their little booklet on "How to Build a House," "How to Rear a Family," and do many other things that a true householder should carry out.

Practical experience in beekeeping is a part of the curriculum in a number of rural schools in the Province of Ontario. In 16 schools in Wentworth County bees are kept in observation hives in the schoolroom. The study involves little extra work on the part of the teacher, and is valuable as a nature contact and in contributing to the promotion of a great productive industry. The sale of honey in many of the schools has been more than sufficient to cover in one season the expense of installation and upkeep.

All-the-year sessions are proposed for the high schools of Omaha, Nebr., following the successful experience of the technical high school with the four-quarter plan. This school has been operating 48 weeks a year for 7 years, and the plan has proved very satisfactory. A 4-year class is graduated at the end of each 12-week quarter. Bright and energetic pupils may complete the entire course in three years. The other three high schools have already adopted an 8-week summer session. —*School Life.*

One-sixth of all the expenditures of the Republic of Cuba during the coming fiscal year will be devoted to education. The budget recently approved by the Cuban Congress carries a total of $83,787,588, and the education department will expend $14,055,166 of it. No other branch of the government received so much. Guatemala's budget for 1926 allots an even larger proportion to education, namely, 18½ per cent; only "treasury and public credit" received more. In the budget of Mexico education stands fifth in the list of items, and it receives 7 per cent of the whole amount appropriated.

Free distribution of textbooks to students will be discontinued in the Bellingham (Wash.) high schools this year because of lack of funds. Books will be bought by the school authorities and sold to students at cost.

A summer school for farm boys between 14 and 21 years of age, who have dropped out of school, was held at the Fletcher Memorial School for four weeks during August, according to South Carolina Education. They were taught agriculture, arithmetic, English, and citizenship.

SAYS EMOTIONAL HOSTILITY TO SCIENCE IS GROWING.

NOTED CALIFORNIA PUBLICIST WARNS OF ANTI-SCIENTIFIC CRUSADE IN WEST.

Emotional hostility to science and scientific methods is becoming more and more active in the United States, according to Chester H. Rowell, one of the foremost publicists of the country, who has just made a survey of conditions on the Coast.

In an effort to check the spread of this hostility, which it contends, is already seriously hampering American scientists, the American Association for Medical Progress, 370 Seventh Avenue, of which Dr. Charles W. Eliot is honorary president, is sending out 5,000 copies of an article, "The Cancer of Ignorance," written by Rowell and published last month in The Survey, a social service magazine.

In this article Rowell declares that the fundamentalists and cultists of southern California especially are so strong that there is danger of a real anti-scientific crusade which will cause an alarming set back to modern education and medical science. The present fight centers on the question of evolution and history on the one hand, and vaccination and scientific medicine on the other.

"For the past year," Mr. Rowell states, "protests against permitting evolution to be taught or to be printed in text books, have been before the state board with at least one member for a time positively favorable to their suppression and some others doubtful. Tactful handling of the situation by the professional staff of the board finally secured a compromise resolution that evolution might be taught as a theory, but not as a fact."

"The fundamentalists now threaten to carry the issue to the legislature and, failing there, to the people by initiative or referendum. If that is done there will be a real crusade, with fears already in the minds of some educators that the large fundamentalist vote of southern California might make some risk of the passage of the laws. Northern and central California being traditionally heathen are not feared."

More serious, perhaps, than the educational fight, is the agitation against medical science and in particular against vaccination. This agitation, Mr. Rowell points out, has already taken the compulsory vaccination clause out of the state law regarding entrance requirements to public schools. The one exception is the University of California, which is governed by its Board of Regents instead of the legislature.

A test case against the Board of Regents is now pending in the California courts. If it fails, the anti-vaccinationists are threatening the Regents, whose terms run for 16 years, with an initiative amendment to the state constitution making their office elective or appointive for short terms.

"Since the change in the state law," Mr. Rowell adds, "smallpox has greatly increased in California and last year there were several outbreaks which took strenuous measures to prevent from reaching dangerous proportions."

Certain cults in the state, Mr. Rowell declares, have centered their anti-medical activities in an organization known as the Public School Protective League. This League interposes legal obstructions to what they regard as baleful health measures and at times even to physiological and hygienic instruction in the public schools.

"They regard bacteriology," he says, "as a sectarian doctrine and have a decision of some court on which they rely, that the physical examination of the throat of a child, during a diphtheria epidemic, unless

by express consent of the parent, is assault and battery. They have gone into active politics against health measures except those which confine themselves strictly to the promotion of cleanliness. That, it seems, is a spiritual virtue and therefore permissible."

It is the traditional confusion of medicine with religion, according to the author, that is responsible for most of the anti-medical agitation and makes the claims of scientific medicine appear to many people like the claims of an established church to suppress dissenters and heretics. Of such persons, faced with scientific demonstration, he says:

"The only question is whether it is virtuous or whether it is wicked, or whether it conforms or does not conform to certain accepted taboos. People who have never in their lives known anything in conclusive evidence and whose most cherished beliefs are based on no evidence whatever are not going to surrender fixed convictions on mere demonstration that they are mistaken or accept anything unfamiliar on mere proof that it is true."

"Anti-science," he sums up, "is something more than mere unscientific thinking or lack of scientific information. It is an active emotional hostility to science; to its conclusions and especially to its process of reaching them. It is a repudiation of the authority of science, of the integrity of scientists and of the validity of the scientific method, and an active practical effort moved by intense feeling, to combat and suppress them."

PROMISING IDAHO COPPER DISTRICT.

A promising copper district in Lemhi County, Idaho, in the vicinity of Salmon is described by a geologist of the Department of the Interior in a report by Clyde P. Ross, just issued by the Geological Survey as Bulletin 774.

Idaho is well known to mining men for its silver-lead mines and, especially in early days, for its gold placers, but its copper deposits are less famous, although copper has been produced in a number of places in the State. Some copper ore has been shipped from the Salmon district, but most of the properties are now in the development stage or are mere prospects. When general conditions in the industry become more favorable to new development and the deposits are more adequately opened up, the district may yield a considerable tonnage of copper ore. Mr. Ross discusses the major features of the geology of the deposits and offers some suggestions to prospectors.

NEW CHEMICAL SPRAY ERADICATES WEEDS.

Selenium compounds were found more useful in destroying weeds than as insecticides for trees and plants by Miss F. Marion Lougee and S. B. Hopkins of the University of Illinois in testing the possibility of substituting selenium for sulphur compounds in plant sprays. Selenium, a chemical substance of the sulphur family, is more poisonous than the latter, but was found to be injurious to foliage. But the properties which make selenium compounds undesirable for spraying trees in leaf may make them useful for combatting pear blight, oystershell scale, blister canker and other plant diseases, in the opinion of the experimenters. Compounds of this substance are very deleterious to such plants as dandelions, burdock, and plantain but hardly affect grass and clover, which may make it a valuable new weed eradicator.

ENGINEERING REPORT ON COLORADO RIVER.

DEPARTMENT OF THE INTERIOR.

Colorado River at present is not only a source of water supply for hundreds of thousands of acres of land in Arizona and California but a menace to these lands. In 1905 the river, as it had done intermittently in the past, broke through its silty banks and forced its way into the low-lying Salton Sea region of California, where, instead of the barren desert of a few years before, there were flourishing irrigated ranches, farm homes, and thriving communities, threatening them with inundation and complete destruction. Much damage was done, but with the expenditure of millions of dollars and more than two years of persistent effort the river was turned again to the Gulf of California. The danger of a recurrence of flow to Salton Sea is ever present, and the safety of great areas of highly productive land and prosperous towns can be assured only by storage of flood waters and maintenance of a well designed system of levees and the bank works protection. Thus safety from inundation, complete use of waters for irrigation, and adequate development of potential power demand storage and regulation works on Colorado River.

The Geological Survey report, published as Water-Supply Paper 556, deals with the comprehensive development of Colorado River below the mouth of Green River, with particular reference to flood control and the development of hydroelectric power. Records of stream flow are summarized, and estimates of water supply available at many points under a variety of conditions are presented. The principal reservoir sites are described, and their availability and usefulness are discussed. Plans, cross sections, and area and capacity curves, together with engineering and geologic discussions, are presented for all known dam sites on nearly a thousand miles of river, all of which has been surveyed and mapped. In summarizing, Mr. La Rue suggests that the scheme of development should be comprehensive and should provide for the maximum practicable utilization of the potential power, the maximum storage of water for irrigation, and above all the effective elimination of the flood menace, and an adequate solution of the silt problem. Such a plan, when executed, necessarily covering many years, would in his opinion include the construction of 13 dams, which would make available 3,383 feet of head or fall for the development of power and a maximum of 42,000,000 acre-feet of storage capacity for the control of floods, equalization of flow, and storage of silt. Under this plan nearly 6,000,000 acres of land could be irrigated by the waters of Colorado River, 3,420,000 continuous horsepower could be developed in the canyons below the mouth of Green River, and a domestic water supply could be made available for a population of 10 to 15 million in urban communities of the Southwest.

Shoe repairing is a part of the curriculum of the Memorial Junior High School, of San Diego, Calif. The course is thoroughly practical, and the 10 lessons comprise a study of foot anatomy, as well as grades of leather, classification of shoes, and the actual work of repairing. One unit of university credit is allowed for the completion of the course and a State credential to teach the subject.

The dental hygienist is the latest specialist in the field of school health He teaches care of the teeth and does the mechanical work of cleaning them. According to information collected by the Department of the Interior, Bureau of Education, one or two year training courses for dental hygienists are now offered by 10 dental schools in the United States.

Do it Now for the Benefit of Humanity

PROBLEM DEPARTMENT.

CONDUCTED BY C. N. MILLS,
Illinois State Normal University, Normal, Ill.

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and to solve problems here proposed. Drawings to illustrate the problems should be well done in India ink. Problems and solutions will be credited to their authors. Each solution or proposed problem, sent to the Editor, should have the author's name introducing the problem or solution *as on the following pages.*

The Editor of the department desires to serve its readers by making it interesting and helpful to them. Address suggestions and problems to C. N. Mills, Illinois State Normal University, Normal, Ill.

SOLUTION OF PROBLEMS.

891. *Proposed by Walter C. Eells, Whitman College, Walla Walla, Wash.*

(Suggested by Problem 873.) Prove that the cube of any integer when divided by 8 leaves the same remainder as does the integer itself when divided by 8, if the integer is odd, and leaves no remainder if the integer is even.

Solved by J. F. Howard, San Antonio, Texas.

(a). $(2n)$ represents any even integer. Hence $(8n^3)$, which is the cube of $(2n)$, is divisible by 8.

(b). $(2n+1)$ represents any odd integer.

$$(2n+1)^3 = 8n^3+12n^2+6n+1$$
$$= 8n^3+8n^2+4n(n+1)+(2n+1).$$

It is evident that each of the first three terms of the right member of the last expression is divisible by 8. Hence the cube of $(2n+1)$ leaves the same remainder when divided by 8 as does $(2n+1)$.

Also solved by *T. E. N. Eaton, Redlands, Cal.; R. T. McGregor, Elk Grove, Cal.; Philomathe, Montreal, Can.; Tillie Dantowitz, Philadelphia, Pa.; W. W. Horner, Donora, Pa.; Henry Ruzicki, Lacey, Wash.; L. Carlitz, Philadelphia, Pa.; J. S. Georges, University High School, Chicago.*

892. *Proposed by George Sergent, Guatemala, C. A.*

Given two adjacent supplementary angles, and the bisector of one of them, construct the bisector of the other, using the ruler alone.

Solved by Philomathe, Montreal, Can.

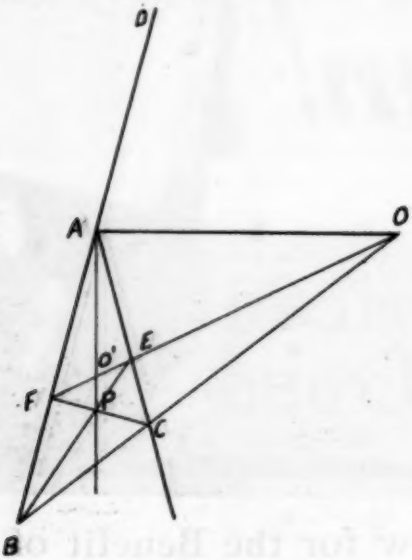

FIGURE X

Given ∠BAC and ∠CAD two adjacent supplementary angles, and the bisector AP of ∠BAC. Draw BP cutting AC at E, and CP cutting AB at F; also FE and BC intersecting at O; then AO is the required bisector.

Proof. AP and FE intersect at O′. We know that O and O′ divide harmonically the segment FE, from a property of the complete quadrilateral BCEFAO. But in the triangle FAE, the base FE is also divided harmonically by the bisector AO′ of ∠ BAC and that of ∠CAD. Therefore AO is the bisector of ∠CAD.

Also solved by *W. W. Horner, Donora, Pa.; L. Carlitz, Philadelphia, Pa.; J. F. Howard, San Antonio, Texas;* and the *Proposer.*

893. *Proposed by A. S. Haynes, Bangalore, S. India.*

Inscribe the maximum rectangle in a given sector of a circle.

I. *Solved by George Sergent, Guatemala, C. A.*

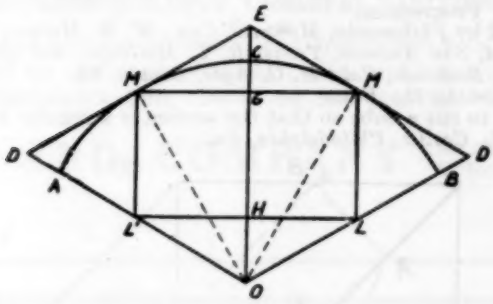

FIGURE XX.

Draw the bisector OC of the angle of the sector AOB, and the bisectors of the angles AOC and COD. Draw MM′ joining the midpoints of the arcs AC and BC. The parallels ML and M′L′ to OC determine the vertices L and L′ on the radii. Then MM′LL′ is the required rectangle.

Proof. Draw the tangents DE and D′E at M and M′. The bisector OC is an axis of symmetry. The maximum rectangle inscribed in the sector BOC is the same as the maximum rectangle inscribed in the triangle EOD. Hence the rectangle HLMG has one of its vertices on the midpoint M of the side DE, (A well known theorem). Similarly HL′M′G is the maximum rectangle that can be inscribed in the sector COA. Therefore LMM′L′ is the maximum rectangle that can be inscribed in the sector AOB.

II. *Solved by Philomathe, Montreal, Can.*

In the Figure used in Solution I, let $\angle MOC = x$, and the angle of the sector equal to α. The area of the inscribed rectangle is 2(HG·GM). Denote the area by A.

$$A = 2r\sin x[r\cos x - r\sin x\cot(\alpha/2)]$$
$$= 2r^2[\tfrac{1}{2}\sin 2x - \sin^2 x\cot(\alpha/2)].$$

Equate to zero the expression for dA/dx, and we have

$$\cos 2x - \sin 2x\cot(\alpha/2) = 0,$$

or
$$\cot 2x = \cot(\alpha/2).$$

Hence
$$x = \alpha/4.$$

Therefore the angle $x = \alpha/4$ will locate the points M and M′, and the area of the required rectangle is $r^2\tan(\alpha/4)$.

Also solved by *W. W. Horner, Donora, Pa.; J. F. Howard, San Antonio, Texas; J. S. Georges, University High School, Chicago;* and the *Proposer.*

894. *Proposed by Royal V. Bryant, Lowell, Mass.*

Prove that the sum of any series of consecutive odd numbers beginning with unity is a perfect square.

I. *Solved by J. S. Georges, University High School, Chicago.*

Assume $1+3+5+\ldots+(2k-1)=k^2$. (1),

Adding $(2k+1)$ to both members of (1) gives

$$1+3+5+\ldots+(2k-1)+(2k+1)=k^2+(2k+1)$$
$$=(k+1)^2. \quad (2).$$

Hence if (1) is true for k, it is true for $(k+1)$. But (1) is true for $k=3$, therefore it is true for $k=4$. Therefore the sum of the above series is a perfect square.

II. *Solved by L. Carlitz, Philadelphia, Pa.*

Let $S=1+3+5+\ldots+(2n-1)$.

Then $2S=1+3+5+\ldots+(2n-1)+(2n-1)+(2n-3)+\ldots+1$.

$=2n+2n+2n+\ldots+2n$ (To n terms)

$=2n^2$.

Hence, $S=n^2$.

The other solutions sent in involved the principles as applied to an Arithmetical Progression.

Also solved by *Philomathe, Montreal, Can.; W. W. Horner, Donora, Pa.; J. F. Howard, San Antonio, Texas; R. T. McGregor, Elk Grove, Cal.; T. E. N. Eaton, Redlands, Cal.; H. G. Ayre, Benton, Ill.*

895. *Proposed by the Editor.*

Show how to cut a cube so that the section is a regular hexagon.

Solved by L. Carlitz, Philadelphia, Pa.

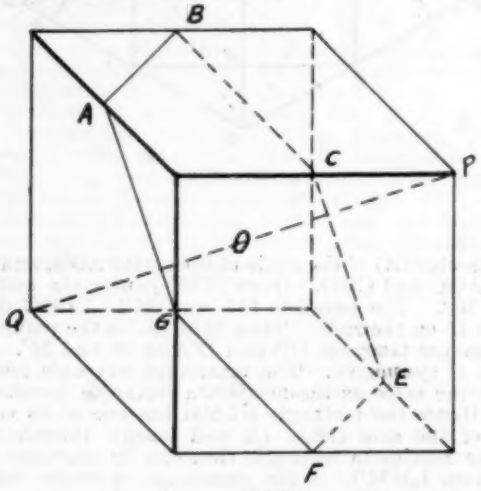

FIGURE XXX.

Draw diagonal PQ. Through O, the midpoint of PQ, pass a plane perpendicular to the line PQ, then the section ABCDEF is a regular hexagon. It is not difficult to prove that the points A, B, C, D, E, and F are the midpoints of the respective edges.

Also solved by *Raymond Huck, Shawneetown, Ill.; J. F. Howard, San Antonio, Texas; J. S. Georges, University High School, Chicago; T. E. N. Eaton, Redlands, Cal., George Sergent, Guatemala, C. A., R. T. McGregor, Elk Grove, Cal.; Philomathe, Montreal, Can.; W. W. Horner, Donora, Pa.*

PROBLEMS FOR SOLUTION.

906. *Proposed by B. F. John, La Salle College, Philadelphia, Pa.*

A block of marble weighing 40 pounds is divided into four parts such that all integral number of pounds between one and forty may be weighed Find the weight of each part.

907. *Suggested by* 893. *Proposed by Philomathe, Montreal, Can.*

Inscribe the maximum rectangle in a given segment of a circle.

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The maps are blue prints 16 inches in diameter. Seven symbols are used to represent degrees of brightness. Brighter stars are made conspicuous by the use of special distinctive symbols. The ecliptic is drawn on each map to help in locating planets. The lines of the constellations are made as helpful as possible. Maps may be mounted if desired, or fastened to a cardboard by paper clips.

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908. *Proposed by P. H. Nygaard, Spokane, Wash.*

What must be the characteristic properties of f(x) such that the mean of the roots of f(x) is the same as the mean of the roots of f′(x)?

909. *Proposed by Norman Anning, Ann Arbor, Mich.*

Describe the circle with center at O(0, 0), which passes through the point P(8, 7). Draw a tangent at P to this circle and on it lay off PQ equal to the distance from (0, 11) to (11, 0). Show that the area of the square on OQ is very nearly equal to the area of the circle. Show also how to continue the construction in order to make it yield an approximation to the circumference of the circle.

910. *For High School Pupils. Proposed by the Editor.*

If three lines be drawn from the acute angles of a right angled triangle, two bisecting these angles, and a third a perpendicular to one of the bisecting lines, then the triangle included by these lines will be isosceles.

SCIENCE QUESTIONS.

Conducted by Franklin T. Jones

The White Motor Company, Cleveland, Ohio.

To Readers of School Science and Mathematics:

You are invited to propose questions for solution or discussion.

You are asked to answer questions.

Examination papers are always desired. Send in your own papers or any others. Some are interested in college entrance examinations, others in school or college examinations. All are desired.

Please address all communications to Franklin T. Jones, 10109 Wilbur Avenue, S. E., Cleveland, Ohio.

PROBLEMS AND QUESTIONS FOR SOLUTION.

477. *Asked by E. D. Campbell, Calgary, Alberta.*

Adressed to the Editor but now proposed to all readers of SCHOOL SCIENCE AND MATHEMATICS.

(*a*) Please send me some copies of papers set on General Science.

(*b*) What is your opinion as to the best text book on *General Science?*

(In answering the above please send your answers to the *Editor* of Science Questions Dept. Your name will not be published as approving any particular text *unless you specifically state* that you are willing to have it published.

(*c*) What text book do you actually use and why?

(*d*) What text book would you prefer to use and why?

478. *Asked by E. D. Campbell.*

What, in your opinion, is the best text book in Chemistry for a student who has had one year's experience in chemistry?

QUESTIONS REPEATED.

Discussion—Pro and Con—on the following questions is earnestly desired:

463. SCHOOL SCIENCE AND MATHEMATICS, April, 1925, page 430, bottom.

464. Same, page 431, lower third.

465. Same, page 434, middle.

The questions themselves are repeated. The examination papers to which they refer are found on pages 432 and 434, SCHOOL SCIENCE AND MATHEMATICS, April, 1925.

463. SCHOOL SCIENCE AND MATHEMATICS, *April, 1925, page 430, bottom.*

In a shop the product has to *pass inspection* before it is approved for use by the maker.] This inspection to be acceptable has to be made by someone other than the workman who made it or the department in which the work was done. Before being accepted by the user it again has to pass a receiving inspection.

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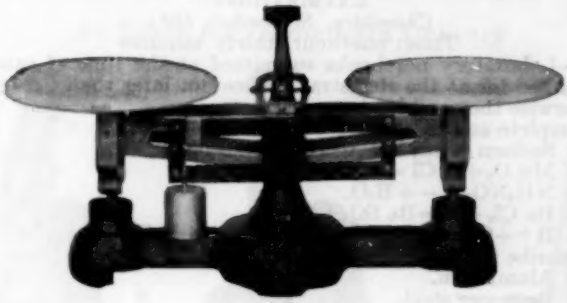

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464. SCHOOL SCIENCE AND MATHEMATICS, *April, 1925, page 432, lower third.*
In what respects do you, as a competent teacher of Physics (or Science), object to this examination paper? Why? Pro's and con's please.

465. In what respects, if any, will such an examination as the New York City examination in General Science help to pass upon the qualifications of a teacher?
What success factors are omitted? How should they be determined? Should an *intelligence* test be given?

EXAMINATION PAPERS.

BOSTON UNIVERSITY COLLEGE OF LIBERAL ARTS ENTRANCE EXAMINATIONS

Chemistry, September, 1924

Time: one hour, thirty minutes

NOTE.—Laboratory notebooks submitted at the time of examination must be called for at the Registrar's office not later than September 20, 1924; otherwise they will be destroyed.

I. Complete and balance:
(1) Sodium chloride + Ag NO_3 = − + Na NO_3.
(2) Mn O_2 + H Cl = + Mn Cl_2 + −.
(3) NH_4NO_3 = − + H_2O.
(4) Ba Cl_2 + − = Ba SO_4 + −.
(5) $H^+ + Cl^- + Na^+ + OH^-$ = − + − + H_2O.

II. Describe the industrial method of making three:
(1) Aluminium.
(2) Bessemer steel.
(3) HNa CO_3.
(4) Na OH.
(5) Litharge.

III. Mark these as *correct* or *incorrect*, and if incorrect, write correctly:
(1) Air contains 20% of hydrogen.
(2) Helium explodes.
(3) Lead is a heavy metal.
(4) The valence of oxygen is 1.
(5) Hard coal contains over 90% of carbon.

IV. State how you preared three of these in the laboratory, and sketch the apparatus used:
(1) Carbon dioxide.
(2) Oxygen.
(3) Chlorine.
(4) Ammonia.
(5) Sulphur dioxide.

V. How many grams of nitrogen would be needed to make 50 grams of ammonia by synthesis?

VI. (1) How would you find the per cent. of water in a potato?
(2) How would you find the equivalent weight of zinc?

VII. What do these mean? H_2, $2H_2$, K^+, $3H_2SO_4$, NO_3^-.

VIII. Suppose you know the weight in grams of 22.4 liters of carbon dioxide. (1) How is this weight related to the molecular weight of carbon dioxide? (2) If you know the atomic weights of carbon and oxygen, how would you find the correct formula of carbon dioxide?
Atomic weights − O = 16, C = 12, N = 14, H = 1.

SUBMITTED BY WALDO W. SPEAR, BERNARDSVILLE H. S., NEW JERSEY

General Science, Midyear Exam., Jan., 1925

1. Health is considered the first aim in General Science. List in short statements all the facts you have learned from experiments, project reports, committee reports in the Science Club meetings concerning health.

2. Change 86° Fahrenheit to Centigrade. By means of a diagram explain the scientific principles illustrated by either the fireless cooker OR a kitchen range OR a heating system.

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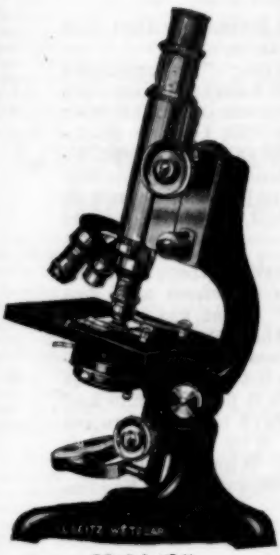

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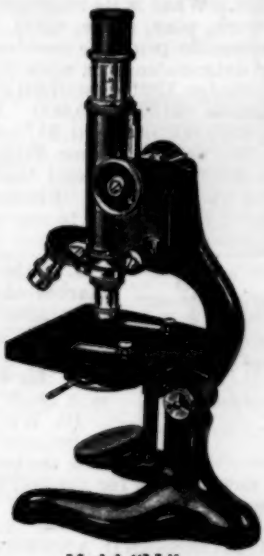

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3. What is the fire loss in the U. S. compared to other countries? Imagine that you are an expert on fire dangers and that you have been appointed by the President of a Fire Insurance company to make a report to him on the causes, the methods of fighting fires both inside buildings and in open land, and on prevention methods. Write such a report and tell in the conclusion what you would like to recommend as an expert.

4. Select some kind of machine that you have in your home and name all the different simple machines of which it is composed. Perhaps a simple diagram will aid you. How would you proceed to raise a piano weighing ¼ ton up to a second-story window if all the strength you can exert is 100 lbs.? What mechanical advantage do you gain by this method?

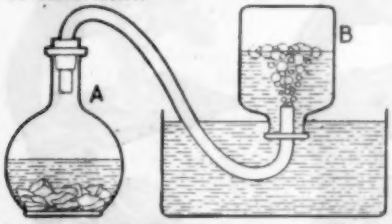
5. Prior to a high school dance the electric meter read 1154 K. W. H. and after this dance it registered 1165 K. W. H. At $.13 per K. W. H. and with the usual discount, how much did the school owe the Board of Education for electric power?

If an electric disk stove in the Science room consumes 600 watts, find how many amperes it takes. What is its resistance?

6. Select any kind of work, play, game, sport, or recreation that you indulge in and list each scientific principle involved in it.

7. Graph the following data stating the scale you use: "Expenditures on automobiles in the U. S. for 1921, distributed as follows: New cars $1,448,000,000; Depreciation $1,800,000,000; Interest $295,000,000; Tires $450,000,000; Gas $823,000,000; Oil $175,000,000; Garage $552,000,000; Repairs $1,000,000,000; Insurance $185,000,000; Taxes $275,000,000; Drivers' Salaries $600,000,000; Road Maintenance $180,000,000.

8. Discuss the following quotations (a) "Electric light bulbs sooner or later burn out." (b) "Water can be made to run uphill." (c) "Radiators radiate heat."



9. In the flask, A, there are some marble chips to which acid has been added. What gas is being collected in the bottle, B? Does it burn? Does it support burning? How is it tested? For what is it used? Is it heavier than air?

10. Who gave the best project in Science? Why do you think it was the best? What did you learn from it? Shall we elect new officers for the last half year in the Science Club? How can the meetings be improved?

SOLUTIONS AND ANSWERS.

458. *Newspaper Clipping.*

How much *power* is used by these automobiles? Get some of your pupils to explain just what is the matter with this piece of advertising in the physical sense?

"Power of Chevrolets

"If the 1,000,000 Chevrolet cars used daily carried only five passengers averaging 150 pounds in weight, each, the total haul would amount to 750,000,000 pounds. To move the same weight by rail would require the use of 12,500 box cars, each car of thirty tons capacity."

How much "power" will it take to haul 750,000,000 pounds on a level brick road (tractive resistance 40 lb. per ton)? How much on a dirt road (100 lb. per ton)?

Solution by W. F. Burbank, Cleveland, Ohio.

The use of the word power is erroneous, as power involves a time element, or rate of doing work. To correspond with the title, the story would have to conclude facts concerning the distance the load was carried, also how long it took to do it. A suitable title for this clipping might be "Tonnage carried by Chevrolets."

In the second part we would have to know the time and distance also in order to give an answer. The force in this case is that used in overcoming tractive resistance.

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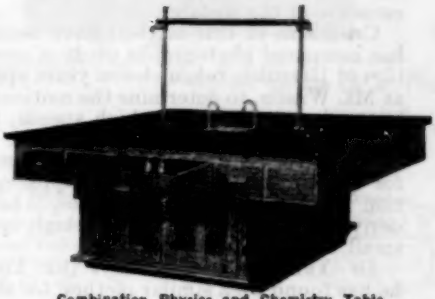

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This design contains two features not to be overlooked. The electric light attachments are new. The small drawers extending through the entire table provide storage room for long condensing tubes and other equipment. This desk will accommodate twenty-four students working in groups of eight.

MOTIONS PROVE STARS AT VAST DISTANCES.

Confirmation of estimates made by Dr. Harlow Shapley, director of the Harvard College Observatory, of the distance of globular star clusters are contained in a series of measurements recently completed by Dr. Adrian Van Maanen, astronomer at the Mt. Wilson Observatory. Dr. Shapley's figures, which placed some of these objects so far away that their light takes a hundred thousand years or more to reach us, though travelling at a speed sufficient to encircle the earth seven times in a second was based on the variation in light of certain stars known as Cepheid variables.

These stars undergo a periodic increase and decrease in their magnitude, the length of the period varies according to the average brightness, and so by watching them for a while, the astronomer can determine how bright they really are. The more distant the star is, the fainter it seems, and so the relation between the actual and the apparent brightness permits an estimate of the distance.

Criticisms of this method have been expressed, but Dr. Van Maanen has compared photographs made of one of these clusters, in the constellation of Hercules, taken eleven years apart with the great 60 inch telescope at Mt. Wilson, to determine the motions of its stars. They are undoubtedly moving and many at high speeds, but Dr. Van Maanen's results revealed practically no motion, and he concludes that this is due to the fact that they are so far away that a much longer time would be required for the movements to become apparent. "This is a beautiful confirmation of Dr. Shapley's distance," he said, "because with the distance derived by him, even a fairly high speed would still give an extremely small motion on the plates."

Dr. Van Maanen also says that his work confirms the motion which he has found by a similar method for the spiral nebulae, cloud-like objects with spiral arms, and which some other astronomers have suggested might be due to some error.

BOOKS RECEIVED

Elements of Applied Electricity by Howard H. Bliss, Riverside Junior College. Pages Old Roman xv+Arabic, 404. 13.50x19.50 cm. Cloth, 1925. Price $1.96. Henry Holt & Co., 19 West 44th St., New York City.

Experiment in College Chemistry by Lyman C. Newell, Boston University. Pages xi+Old Arabic, 320. 14x20.50 cm. Cloth, 1925.

D. C. Heith, Boston, Mass. Introduction to the Statistical Analysis by George G. Chamber, University of Pennsylvania. 14.50x22 cm. Cloth. F. S. Crofts & Co., New York.

Guide to Physics by John W. McCormack, Stuyvesant High School, New York City. Pages x+119. 13x19 cm. Cloth, 1925. Globe Book Co., New York.

Elements of Chemistry by William Foster, Princeton University. Pages xviii+576. 15x22 cm. Cloth, 1925. Price $2.00. D. Van Nostrand Co., New York.

Inorganic Quantitative by Harold A. Fales, Columbia University. Pages xvii+493. Cloth, 1925. Price $3.50. Century Publishing Co., New York.

Everyday Physics by H. F. Hadley, Principal School of Science, Kidderminster, London, England. Pages xviii+424. 13x19 cm. 1925. Macmillan & Co.

Pyschology of Vocational Adjustment by Harry Kitson, Teachers College, Columbia University. Pages ix+273. 13.50x19.50 cm. Cloth, 1925. J. P. Lippincott, Chicago.

College Geometry by Nathan Altshiller-Court, D. Sc. University Oklahoma, Norman. Pages xiii+254. 16x24 cm. Cloth, 1925. Johnson Publishing Co., Richmond, Va.

Plane Curves of the Three Order by Henry S. White, Vassar College, Poughkeepsie. Pages xii+168.

Gems and Gem Material by Edward H. Krous and Edward F. Holden, University of Michigan. Pages vii+222. 16x23.50 cm. Cloth, 1925. Price $3.00. McGraw-Hill Book Co., New York.

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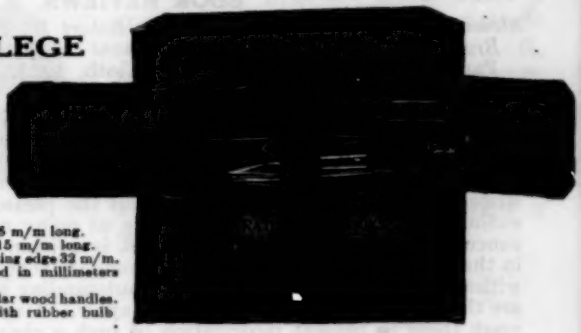

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BOOK REVIEWS.

Elementary Principles of Physics by Robert W. Fuller and Raymond B. Brownlee, and D. E. Baker, Stuyvesant High School, New York City. Pages xi+859+13. 13x19 cm. Cloth, 1925. Allyn & Bacon Publisher, Chicago, Ill.

This is another fine text in elementary physics which has recently come from the press. There are no adverse criticisms of any seriousness that the reviewer of this book wishes to make. At the very outside he will say that it is without doubt one of the very best books that the writer of this little paragraph has had the pleasure of reviewing. The authors have endeavored to eliminate as many new terms and abstract concepts as was possible, and the book is written from beginning to end in that kind of language which the secondary school pupil can understand without any difficulty. Among the outstanding good points in the book are the exercises at the end of each chapter. Much thought has been put upon these to present information of such a character as will fix in the minds of the pupils the features which have been discussed in that chapter. Another thing is that frequently during the process of the discussion in any particular chapter numerous questions are asked which will drive home the subject matter under discussion. And, too, there are a number of demonstrative experiments placed in the book and selected from the authors' extensive experience in the teaching of Physics. There are some 728 drawings and illustrations all of which have been selected with the point in view of illustrating the subject matter that has just been discussed. Many of these drawings have been made especially for this work. Major paragraphs all begin with bold face type which in a measure indicates in a few words the nature of the subject matter to be discussed in that chapter. It is a book that should be examined carefully by every board and inspector who is contemplating the introduction of a new text in physics. C. H. S.

Elements of Electricity by Howard H. Bliss, Junior College, Riverside, Calif. Pages xv+494. 13½x19 cm. Cloth, 1925. Price $1.96. Henry Holt & Co., New York City.

This splendid book is divided into two parts. Chapters 1 to 14 consist of the general survey of the field of electrical work. The second by Chapters, 14 to 46, is applied to the extension of the fundamental principles given in the first part. If the students have a good knowledge of the first part, they will not have much difficulty in the permanent and practical problems of the second section. Special emphasis is laid upon the particular problems in the second part of the book. They are practical from beginning to end, and anyone mastering them will have a splendid comprehension of what practical electricity is. It is well written and full of interesting projects. It is printed in ten-point type on partially calendered paper. Major paragraphs, stating the gist of the work in that paragraph, all begin with bold face type. It is filled with practical problems to the extent of 400. The drawings have been carefully made and illustrate clearly the subject matter. Any school contemplating the introduction of such a course cannot do better than adopt this book.

Guide to Physics by John W. McCormack, Stuyvesant High School, New York City. Pages v+119. 13x19 cm. Cloth, 1924. Globe Book Co., New York City.

This is a typical manual in physics and contains those classical experiments with which physicists believe each high school pupil should be familiar. Many practical questions and problems are scattered throughout the text. It is written clearly and altogether is a fine manual to put in the hands of secondary school pupils. C. H. S.

Everyday Physics by H. E. Hadley, Principal, School of Science, Kidderminster, London, Eng. Pages viii+474.

An English text printed in the characteristic form of that country. Much care apparently has been taken in the selection of the material. It has been written primarily for secondary school students. It is practi-

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Smith's Elementary Chemistry

Revised and rewritten

By JAMES KENDALL

with collaboration of

S. Walter Hoyt, J. Collin Moore, J. M. Kelso, Ellinor Garber, and Ray McClellen

12 mo *437 pages* *Price $1.80*

Although this is a complete revision of the original text and, as far as content, is practically a new book, it retains the spirit and purpose of the first Smith edition. Its aim is to train the pupil to acquire the scientific outlook, to correlate his knowledge, and to lead him to an appreciation of the underlying principles, rather than the surface facts, of chemistry. A number of new features have been added to the text and material has been included to cover the developments in the field of chemistry during the past ten years. Although not a descriptive text there is a large amount of descriptive matter included by way of illustration and there is also much applied chemistry with many excellent pictures of manufacturing equipment.

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cal in its treatment of the subject matter. It is divided into twenty-three chapters. Major paragraphs begin with bold face type which gives the key to the matters discussed in those paragraphs. The paper is not highly calendered thus relieving itself of the intense glare of reflected light. There is a long list of selected practical problems given in the rear together with several tables of constants. It is well indexed. All physics teachers should have a copy and study with care.

C. H. S.

Psychology of Vocational Adjustment by Harry D. Kitson, Teachers College, Columbia University. Pages ix+373. 13x19½ cm. Cloth, 1925. J. P. Lippincott, Chicago, Ill.

Of the making of books there appears to be no end. Good and poor ones are coming constantly from the press. This book, however, is splendid in all of its details, and is designed primarily to point out the psychological problems which confront one in choosing a vocation. It also discussed the attempts which have been made to obtain a solution; also much material which can be utilized in exploring the field that remains to be uncovered. It is a book which all secondary school teachers, whether proficient in psychology or not, should secure and study, as to be successful in teaching nowadays surely requires a knowledge of psychology.

C. H. S.

Everyday Problems in Science by Charles J. Piper, University of Chicago High School, and Wilbur L. Beauchamp, University of Chicago High School. Pages xxxiv+600. 6.50x7¾ cm. Cloth, 1925. Price $1.60. Scott Foresman Co., Chicago, Ill.

This is without doubt one of the most painstaking up-to-date, cleverly written general science texts that has recently come from the press. The authors surely have hit upon the most vital subjects in Science to be given to youngsters in first year high school. Without question they have made it most interesting in subject matter. It is written in clear concise style, diction being splendid. Major paragraphs are given in bold-face type. It is printed in splendid ten-point type. It is printed on paper that is not highly calendered. Very numerous practical problems are scattered throughout the book. The drawings and cuts of which there are 508 have been well selected for the purpose of illustrating clearly the subject matter. Most of these cuts have been made especially for this text. There are seventeen chapters, each chapter being a study of certain problems which are carefully and masterfully discussed under that head. There are a number of very valuable tables in the appendix. It is splendidly indexed on twenty double column pages. It is a book with which every general science teacher who has the subject at heart should be familiar.

C. H. S.

Health Through Prevention and Control of Diseases by Dr. Thomas D. Wood, Teachers College, Columbia University, and Dr. Hugh G. Rowell, Teachers College Columbia University. Pages vi+111. 14x20 cm. Cloth, 1925. Price $1.00. World Book Co., 2126 Prairie Ave., Chicago, Ill.

A rare book written and prepared largely for use in the public schools. There are fourteen chapters, each divided into particular phases of work with which the public school has to deal. It is a book that should be on every teacher's desk. It is well written; diction is splendid. It is printed on uncalendered paper making it a book easy to read.

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Every Day Problems in Science by John J. Pieper, University of Chicago High School, and Wilbur L. Beauchamp, School of Education, University of Chicago. Pages xxxiv+600. 14x19.50 cm. Cloth, 1925. Price $1.60. Scott, Foresman and Company, Publishers, Chicago.

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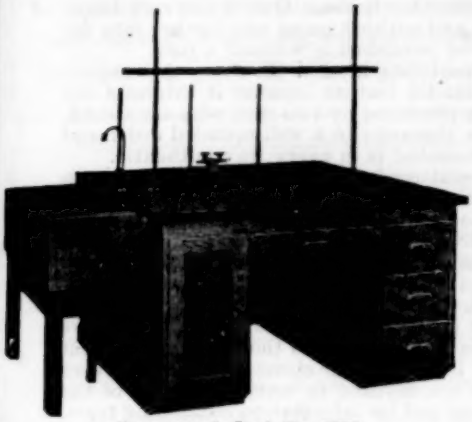

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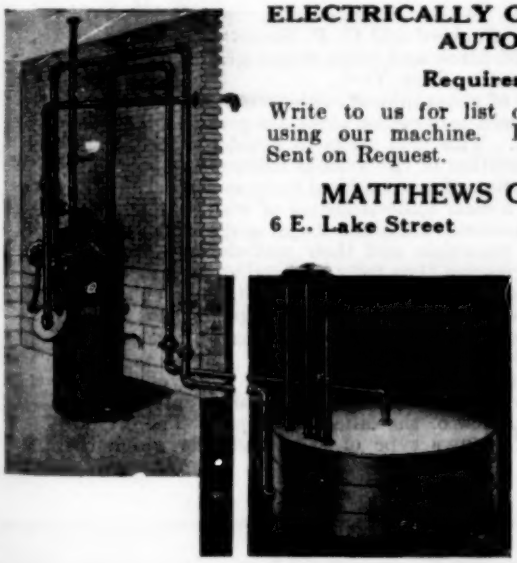

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